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JOURNAL
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VOL. 17 AUGUST, 1924 NO. 4

Proceedings of the Thirty-sixth Annual Meeting of the American Association of Economic Entomologists

(Continued)

Section of Horticultural Inspection

(Saturday, December 29, 1923)

The meeting of the Section of Horticultural Inspection convened at 1:30 P. M. with Chairman P. A. Glenn presiding. After a few preliminary remarks and the appointment of a nominating committee, the Chairman called for the motion picture entitled "Halting Foreign Plant Foes." This picture illustrated some of the most important activities of the Federal Horticultural Board, laying special emphasis on the inspection and fumigation work conducted at various maritime and border ports of entry.

RECENT WORK OF THE FEDERAL HORTICULTURAL BOARD

By C. L. MARLATT

(Abstract)

A brief review was given of the more important activities of the Federal Horticultural Board during the calendar year 1923. Reference was made to several important conferences held in Washington and elsewhere. Recent changes in the Board's organization were mentioned, and followed by a short discussion of the finding of the Mediterranean Fruit Fly in Almeria grapes arriving at the ports of New York, Boston, and Philadelphia, from Spain.

HORTICULTURAL INSPECTION METHODS IN CALIFORNIA

By LEE A. STRONG

(Abstract)

A brief, general discussion was given of the work performed by the Bureau of Plant Quarantine and Pest Control in California. Various

phases of the inspection work of that state were treated, including the examination performed at San Francisco and other ports of entry for the purpose of intercepting injurious insects and plant diseases which may arrive in shipments, or in ships' stores or passengers baggage, the inspection and certification of nursery stock, inspection of incoming domestic material at the freight and express offices and the Post Office.

THE FIGHT AGAINST THE GIPSY MOTH IN NEW JERSEY

By THOMAS J. HEADLEE, *State Entomologist*

ABSTRACT

The eight hundred and fifty-five gipsy moth (*Porthetria dispar* Linn.) colonies in New Jersey in 1920–1921 were reduced to two hundred and sixteen in 1921–1922 and further reduced to ninety-eight in 1922–1923. Fifteen areas of slight infestation unconnected with the main area were apparently completely exterminated by the completion of the work in 1921–1922. Five hundred square miles of the original area of infestation has been reduced to about two hundred and fifty square miles. With the completion of the year 1922–1923 approximately $778,335.31 have been spent of which approximately one-half had been furnished by the state and private sources and one-half by the United States Department of Agriculture.

Infested shipments of nursery stock have been received from New England as follows:—In 1921–1922 twelve; in 1922–1923 fourteen; 1923–1924 (report to December 12, 1923) two. Ultimate success in gipsy moth work in New Jersey means, not only the extermination of the present infestation but, the prevention of reinfestation from any source whatsoever and, consequently, New Jersey has a vital interest in the prevention of the spread of the gipsy moth from the great infested area in the New England states.

At each of the three meetings of this society held previous to this one the writer has presented a statement of the warfare against the gipsy moth in New Jersey. Much of the detailed data which he presented in these papers has been superseded by statements based upon more complete information. The revised statistics are found in the 6th, 7th and 8th annual reports of the New Jersey State Department of Agriculture, which are listed as bulletins 29, 33 and 37 of that organization. Still further information of a detailed character can be found in circulars 38, 56 and 67, issued by the same organization. It is only fair to say, however, that the general tenor of the data submitted by the writer has not been changed by the obtaining of more complete information and that the conclusions reached by him stand firm.

If he were listening to a statement of this sort from another state he would want to know first the results obtained in this warfare and second what the warfare had cost. Because of the existence and availability of this detailed data to which the writer has referred and be-

cause he believes that your desire for information concerning the warfare against the gipsy moth in New Jersey is probably very similar to his own he will confine his statement of data to results and to expenditures.

TABLE No. 1

Year	Size of main area in sq. miles	No. of colonies	No. of egg masses	No. of areas outside main area	No. of colonies	No. of egg masses	No. of gipsy moth infests found on imports untreated egg masses or larvae
1920-'21	500	855	3,003,039	15	6	40	
1921-'22	500	216	909	15	0	0	12
1922-'23	250	98	1,182	0	0	0	14
1923-'24*	25% scout'd	26	353	0	0	0	2

*Report to December 12, 1923.

Table No. 1 shows that in the course of the three completed years of warfare all outlying infestations of gipsy moth have been exterminated, that the original five hundred square mile area of scattered infestation has been cut to about two hundred and fifty square miles, that each year has seen a large reduction of the number of colonies within the main area and that the extermination of the insect within this area looks to be practicable.

This table also shows that a menace to the extermination of the gipsy moth in New Jersey exists in the form of infestations being brought into New Jersey on imported products. It happens that these products are exclusively, in the instances where the infestations have been found, composed of nursery stock.

TABLE No. 2

Year	Total	Funds Federal	State	Private
1920-'21	259,495.04	122,495.04	112,000.00	25,000.00
1921-'22	226,572.61	101,672.61	125,000.00	
1922-'23	292,267.66	167,267.66	125,000.00	
1923-'24	?	?	125,000.00	

Table No. 2 serves to show the expenditures and the distribution of source among federal, state and private agencies. The sums recorded in this table are large, but the nature of the work of extermination is such apparently as to forbid the use of smaller sums.

The gipsy moth problem cannot safely be considered from the standpoint of one state alone. If it is granted that the gipsy moth may be exterminated in New Jersey there is absolute certainty of reinfestation unless other infestations from which gipsy moth may be carried into that state are considered and the problems involved in preventing this transportation of infestation met and solved.

The writer feels that it is fair to assume that infestation coming from foreign countries, either on this continent or elsewhere, will be prevented through the activities of the Federal Horticultural Board in cooperation with state agencies. This being the case, the gipsy moth problem then involves either the extermination of all infestations within the limits of the United States, or the extermination of part and the adequate prevention of the movement of infestation from the balance. As matters now stand it looks as if gipsy moth infestations outside of New England can and will be exterminated. It also looks as if extermination of Gipsy moth infestations within the New England States cannot be accomplished in a limited space of time, and that therefore exterminative work should be pursued in dealing with all infestations outside of the New England States and that movement of infested material from the New England States into other parts of the United States should be so restricted as absolutely to prevent the escape of infestation from that area into other parts of this country.

STATUS OF HYDROCYANIC ACID GAS TREATMENT OF NURSERY STOCK

By JOHN J. DAVIS, *Purdue University, Lafayette, Ind.*

ABSTRACT

Summarizes complaints from both nurserymen and from orchardmen relative to injury to nursery trees when fumigated with hydrocyanic acid gas and the factors involved. The need of further experiments with the gas and additional materials and probable plans for such investigations are suggested.

With the early recognition of the San Jose scale as an orchard pest of first-rate importance and the recognition of the nursery as the biggest factor in its spread to new localities, state laws were enacted in rapid succession. The discovery of the value of hydrocyanic acid gas as an effective agent against the scale and the comparative ease with which it could be used led to the almost universal adoption of this method of treating nursery stock.

We have all heard of occasional complaints from both nurserymen and from orchardmen relative to supposed injury to trees by hydrocyanic acid gas. Probably none of us, however, have recognized these complaints as general because they were not openly brought to our attention. When the matter was first brought to the writer's attention a year ago by Mr. R. A. Simpson, following his presentation of the subject to the Illinois Horticultural Society, we immediately made an effort to gather

evidence relative to the basis for the complaints and the possible remedies for the situation.

The letters received by Mr. Simpson from prominent nurserymen and orchardmen from eight or ten states, were unanimous in condemning the present methods used in treating nursery stock and in presenting evidence to prove the injurious effect of the gas on trees. In our personal talks with nurserymen and orchardmen in Indiana similar views were expressed. Nearly all admitted its effectiveness as a scale destroyer and that it was probably harmless to trees which were perfectly dry at the time of fumigation but that it was impractical to always have trees in the right condition for fumigation and that varying results are unavoidable.

We would quote a few extracts from letters received by Mr. Simpson which we know to have come from nurserymen and orchardmen who are reliable and who are themselves interested in preventing the spread of harmful insects.

One writer says, "If fumigation is done when the trees are perfectly dry, both tops and roots, with chemicals of proper strength, and in the hands of a careful and competent man it is all right, but there have been more trees damaged by fumigation than have ever been benefited, in the writer's judgment." Another nurseryman writes: "After we began fumigating our stock we received a lot of complaints that the trees were not breaking bud and that they were practically losing from 90 to 100 per cent of the stock we had delivered. We know from our own personal experience that under certain conditions nursery stock will probably not be injured from fumigation, but the conditions vary. One can hardly tell just when they are exactly right. We believe that if trees were thoroughly dried off, roots and top, before placing them into the fumigating room, and then watched very carefully, that there would probably not be any damage, but let there be the least moisture on the roots, or the twigs of the trees, and the fumigation is done according to the present formula, we are satisfied that injury will result. The great trouble with fumigation, as we see it, is that you are never certain just what you have done; whether you have killed the scale, if any, or whether you have not killed all the scale. There is no way to determine excepting to await results." Most of the men answering Mr. Simpson's inquiry reported specific cases of injury. The orchardmen were equally emphatic in their wish to plant only trees which had not been fumigated.

The following extract expresses the view of at least one state inspector: "This fall, one of the leading inspectors of a large fruit-growing

state called on us, and as he is handling trees himself and is also planting out some orchards of his own, he asked us if we would not send him trees without fumigating, although the laws of his state are very strict along this line. We told him that we would have to obey the state law, and he did not place his order with us, and has not up to this date. The fact of the matter is, this man told me personally that thousands of trees coming into his state, that had been fumigated, were injured and he did not want his fumigated." Can we wonder at the complaints when those whose duty it is to uphold the law attempt to evade it and who point out in such a striking manner the possible harmful results if properly enforced?

Where ideal conditions are obtainable, as is possible in experimental work, fumigation with hydrocyanic acid gas can be done with effective results and without injury to trees. However, even under such conditions, injury is possible. Mr. K. C. Sullivan in summarizing his investigations on the treatment of nursery stock[1] writes, "All strengths of the hydrocyanic acid gas caused more or less injury to the plants.* * * The 1–1–3 formula should always be used in fumigating nursery stock, and the stock should be dry. There may be greater danger of injury to plants, but the scale will be more completely controlled, and this is the most important factor." Do entomologists realize that while the control of the insect is a most important factor that it is equally important that the remedy be not more severe and fatal to the plant than the insect itself?

With their belief that fumigation may sometimes injure stock, many nurserymen, otherwise conscientious, probably do not take the pains to practice fumigation in a way to get effective scale control.

These points bearing on the fumigation of nursery stock have been briefly discussed to emphasize the need of further investigations to prove or disprove the use of hydrocyanic acid gas for nursery trees, to secure other means, if necessary, which will be thoroughly effective and harmless to trees, cheap and practical. The results should be sufficiently definite and clean cut that we will have reason to retain or change our state law. We believe there is no question that when thoroughly used under conditions which are practical in the nursery that the gas may be harmful to nursery trees and that complaints from nurserymen and orchardmen are justified.

Believing the subject one which could best be handled through the Crop Protection Institute, the suggestion has been made to the American

[1]Bul. Mo. Agr. Exp. Sta., No. 177, Dec. 1920, p. 34.

Nurserymen's Association to appropriate a sum to permit a complete and thoroughgoing investigation. It is not unlikely this Association will make such an investigation possible and in such an event, the entomologists are urged to carry on such tests in their respective states as may be necessary to corroborate the results.

IMPORTANT FOREIGN INSECT PESTS COLLECTED ON IMPORTED NURSERY STOCK IN 1923

By E. R. Sasscer

(Abstract)

During the year insects were intercepted on plants and plant products arriving from some ninety-three countries, islands, and provinces. Ninety-one coccids identified to the species were collected and many others were intercepted which could be placed in the genus only. During the months of January and February a number of shipments of French nursery stock arrived infested with such insects as the Sorrell Cutworm (*Acronycta rumicis* L.), the White Tree Pierid, (*Aporia crataegi* L.), *Notolophus antiqua* L., and *Calophasia lunula* Hufn. The condition of these plants was promptly brought to the attention of the Chief of the Phytopathological Service of France, which resulted in subsequent shipments showing a much less degree of infestation. The Oriental Fruit Moth (*Laspeyresia molesta* Busck) was found to infest peaches from China; and *Emphytus cinctus* L. was taken on a number of occasions on Manetti stock from France, Holland, Ireland, and England. Three shipments of pear seedlings from France bore nests of the Brown-Tail Moth (*Euproctis chrysorrhoea* L.); and the European earwig (*Forficula auricularia* L.) accompanied fuchsias from Germany and special permit material arriving from England and Ireland.

The European Corn Borer (*Pyrausta nubilalis* Hubn.) was taken in a number of shipments of broom corn arriving from Italy and Hungary; and the Pink Bollworm (*Pectinophora gossypiella* Saund.) was taken in cotton seed arriving from Hawaii, Mexico, Porto Rico, England, and Dominican Republic. Grapes from the Province of Almeria, Spain were found to be infested with the Mediterranean Fruit Fly (*Ceratitis capitata* Wied.); and this insect was also collected in apples from France, peppers, chrysophyllum, coffee berries, *Jabosa malaccensis*, avocados, and rose apples from Hawaii; and sapodillas, mangoes, and guavas from Jamaica were infested with the West Indian Fruit Fly (*Anastrepha fraterculus* Wied.). The Mexican Fruit Fly (*A. ludens* Loew)

was taken in mangoes and oranges from Mexico; and an unrecognized species of *Anastrepha* was present in mangoes and plantains from Porto Rico and oranges from Trinidad.

Egg masses of the Gypsy Moth (*Porthetria dispar* L.) were found attached to raw cork arriving from France; and the following wireworms were found in soil accompanying privet plants from Norway: *Athous niger* L. and *Agriotes sputator* L. Irish potatoes from Peru were infested with a species of *Trypopremnon;* and Mexican grown potatoes used as ships' stores were found to contain larvae of *Epicaerus cognatus* Sharp, which apparently does not occur in the United States. The latter insect has been found in potatoes arriving at New Orleans, Galveston, and Baltimore. A complete list of the insects and plant diseases intercepted on plants and plant products for the calendar year 1923 will be published elsewhere by the Federal Horticultural Board for the use of plant quarantine officials.

AMERICAN PLANT PRODUCTION UNDER QUARANTINE

By R. Kent Beattie

(Abstract)

With every importation of plants there is a risk of bringing plant pests. America needs plants. Quarantine 37 has developed a system by which propagating stock can be brought in under safeguards and the plants produced here. The quarantine has been in effect four and one-half years. Three thousand, one hundred and seventeen special permits have been issued: importation has been made under 2,205; 291 are still valid; 55,542,302 plants have been authorized entry; and 29,885,712 imported. 18,796 varieties have been requested; and of these 93 1/10% have been authorized entry as unavailable for propagation in America.

American plant pathologists and entomologists have the opportunity of assisting this resulting great American horticultural development by studying the pathological and entomological problems faced by American plant growers.

REPORT OF COMMITTEES

Dr. T. J. Headlee, as Chairman of the committee appointed at the Boston meeting of the Section of Horticultural Inspection to look into the desirability of a uniform inspection certificate, submitted the following report:

STATEMENT OF THE PURPOSE, THE ORIGIN AND THE WORK OF *a Special Committee* FROM THE SECTION OF HORTICULTURAL INSPECTION OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS ON THE UNIFICATION OF NURSERY INSPECTION IN THE UNITED STATES

PURPOSE

During the Boston meeting, held in 1922–1923, before the section of the American Association of Economic Entomologists devoted to Horticultural Inspection, Mr. F. F. Rockwell read a paper on the subject of "Bugs, Bugologists, Bugaboos and Nurserymen" in which he entered a strong plea from the nurserymen's standpoint for uniform inspection and certification (particularly the latter) of nursery stock.

During the same meeting Dr. Leonard Haseman, State Entomologist of Missouri, presented a paper entitled "Inspecting Nursery Stock at Digging Time," Jour. Ec. Ent. Vol. 16, on pages 143–144 of which he brought out, from the official inspector's standpoint, the necessity of uniform inspection and certification of nursery stock.

The chairman of the section, Mr. E. N. Cory, was empowered by a motion to appoint a special committee, the business of which should be to see what could be done toward working out the unification, of which the nursery business, according to Mr. Rockwell, stood so greatly in need.

The committee on resolutions of the American Association of Economic Entomologists, in submitting its report after this action had been taken in the section of Horticultural Inspection, included the following statement, which was duly passed by the Association:—

> "*Resolved*, That it is the sense of this association that a uniform United States tag should be required to permit interstate movement of nursery stock and that the machinery necessary to the qualifying inspection should be worked out co-operatively between the United States Department of Agriculture and the authorities of the various states."

ORIGIN

Mr. E. N. Cory appointed the following committee:—Thomas J. Headlee, New Jersey, Chairman, F. M. O'Byrne, Florida, G. M. Bentley, Tennessee, E. C. Cotton, Ohio and E. R. Sasscer, Washington, D. C. After much correspondence it was found by Mr. Cory that Mr. E. C. Cotton could not serve and Leonard Haseman of Missouri was appointed in his stead.

WORK OF THE COMMITTEE

This committee was not able to hold any meeting until the Cincinnati assembly of the American Association for the Advancement of Science, although a considerable amount of correspondence was carried on among the members. At the meeting of the committee held in Cincinnati, it was decided to present a report to the Section of Horticultural Inspection of the American Association of Economic Entomologists in which was laid down a tentative plan for the creation of a strong organization adequately financed to carry on the necessary inspection work of the country and to carry out that work along the lines of certain general principles, which, it was decided, to include also in this tentative report. It was also decided to ask either the discharge of the present committee or its continuation with power of enlarging its personnel as it saw fit. The nature of the plan included in this report follows herewith:—

Main Outlines of Plan for Unification of Nursery Inspection of the United States

The enormous and confusing variety of rules and regulations now governing the movement of nursery stock (including greenhouse stock) from various parts of the United States into other parts of this country work, it is believed, an unnecessary hardship upon both the nursery business and the nursery inspection services of the various states and of the United States Department of Agriculture. Many nurserymen complain bitterly of the unwarranted interference which these rules and regulations create in the conduct of their business and horticultural inspectors frequently find themselves at a loss, not only to understand the usefulness, but the meaning of many of the rules and regulations now in existence in the various states.

In view of these facts the following proposal is submitted for the purpose of seeing whether this multiplicity cannot largely be done away with and, at the same time, the protection rendered to agriculture be made fundamentally better and more far-reaching.

ORGANIZATION TO DO THE WORK

The organization to perform the work of preventing the spread of injurious insects and plant diseases through the distribution of nursery stock of all kinds originating within the boundaries of the United States shall be: (1) Composed of the Federal Horticultural Board and the Inspection Services of the various States; (2) Controlled by a board of directors of six men trained and experienced in work of this sort. Three members of this board shall be designated by the Federal Horticultural Board and three members shall be elected by the Inspection Services of the various states. Each of these three members representing the Inspection Services of the various states shall be chosen from the standpoint of geographical location, one representing the northern, one representing the southern and one representing the western sections of the United States. The full term of office shall be three years and the terms of two members shall expire each year.

INSPECTION

Preliminary inspections shall be made at any time during the year when, in the judgment of the controlling board of the combined service, such action is likely to lead to the discovery of injurious insects or plant diseases that either could not be found at shipping time, or could be eliminated by the nurserymen previous to shipping time.

Inspection shall be made at the time the stock is offered for shipment and the condition of this stock with regard to injurious insects and plant diseases shall form the basis for issuance of certificates.

CERTIFICATION

Certificates issued for inter-state shipment shall be United States tags. Certificates shall cover only the stock to which they apply as shown by accompanying list. Certificates shall specify the territory into which the stock covered by them may be shipped. Certificates shall cover only the condition of the stock as far as injurious insects and plant diseases are concerned.

FUNDS

The moneys necessary to finance this joint organization shall be drawn from both the Federal Horticultural Board and the Inspection Services of the various states.

The total fiscal requirements for the inspection work in any state shall be determined and the funds to meet the needs shall be drawn equally from the Federal Horticultural Board and the Inspection Service of that state.

The Committee on Nominations for the year 1924 reported as follows: Chairman, E. R. Sasscer; Secretary, W. B. Wood. On motion, the ballot was cast and these officers elected for the ensuing year.

There being no further business, the session adjourned at 4:30 P. M.

BIOLOGICAL CONTROL OF PRICKLY-PEAR IN AUSTRALIA: CONTRIBUTING EFFORTS IN NORTH AMERICA

By JOHN C. HAMLIN, *Officer-in-Charge,*
Prickly-pear Investigations, Commonwealth Prickly-pear Board

ABSTRACT

The introduction from North America of natural enemies of Australia's introduced prickly-pear pest has been under way about three years. This paper records the methods of rearing, packing, and shipping the insects, and the equipment employed in this special project. The insects shipped, number of times sent, and the number of individuals consigned are also briefly shown. The relation of the North American work to the present effort in Australia is summarized. Notes on several important cactus insects from Mexico are included, as is a statement of the cactus diseases dealt with.

INTRODUCTION

In furtherance of the Australian Government's project for biological control of the prickly-pear pest, North and South America were selected as the areas whence the natural enemies of cactus were to be imported. This statement deals with the work performed in North America in connection with studying, collecting, breeding free from parasites, and forwarding cactus enemies to Australia. During the two years ended October 31, 1922, the writer (then Entomologist and Biologist to the Board) was charged with this phase of the work, while Mr. E. Mortensen, Assistant Entomologist, continued the work during the succeeding sixteen months.

ACKNOWLEDGMENTS

Both the Board and the writer are deeply indebted to many individuals and institutions throughout the United States and Mexico. Below are mentioned only those who were especially instrumental in bringing about the results recorded in this paper.

Throughout the work in North America, Doctor W. D. Hunter's close contact with it has enabled him to render the Commonwealth

Prickly-pear Board an invaluable service in the capacity of directing agent. The accomplishments have been profoundly influenced by his direction.

The helpfulness of Doctor L. O. Howard, both personally and through his staff of assistants, has been a notable contribution to our work. Entomological specialists of the United States National Museum have been unanimous with their generous aid at all times. Messrs. J. L. Webb, D. C. Parman, and T. C. Barber of the Bureau of Entomology have been constant sources of help.

To Doctor David Fairchild we are especially indebted for making available the Plant Introduction Garden at Miami, Florida as a field station, and for arranging several most useful connections with various people. His officer at Miami, Mr. Edward Simmonds, gave unstinted aid throughout the Florida work.

Doctor J. J. Thornber sent specimens of a cochineal insect from Arizona which is among the most important organisms dealt with in the work.

Doctor J. K. Small generously allowed the use of his cactus garden on the Charles Deering estate at Buena Vista, Florida, and the superintendent of this estate, Mr. Morrison, has been most helpful.

For extensive helpfulness in regard to the cactus diseases Doctor F. A. Wolf is an outstanding figure. Doctors W. A. Orton, O. F. Burger, and J. J. Taubenhaus were also contributors to our work in this connection.

During investigations in the Republic of Mexico, Doctor A. L. Herrera, Mr. J. M. Gallegos, and Doctor N. P. Escobar have most kindly facilitated our work.

One of the greatest contributions was that of the Oceanic Steamship Company. All consignments were sent via their S. S. "Sonoma" absolutely free of charge, and the company designated the Second Officer to give personal care enroute as per our instructions. Furthermore, this generous concern returned all empty shipping cases from Australia without cost. In this way a total of 207 cases were transported for the Board. Mr. H. I. Graham was largely instrumental in making these concessions.

Preliminary Activities

During November and December, 1920 the writer was fortunate to secure an excellent orientation with the project by conferring with many specialists in subjects pertaining to the problem, by inspecting the

Gypsy and Browntail Moth and European Corn-borer laboratories near Boston, and by a survey of the cactus country of Texas.

The field survey of southern Texas, outlined by Doctor W. D. Hunter, included Kingsville, Brownsville, Laredo, Uvalde, and San Antonio. Aside from permitting an acquaintance with the cactus enemies, this round made possible the selection of the most suitable locality for subsequent Texas work. The considerations affecting the choice were: number and abundance of cactus insects, presence of a United States entomological station with available working space to spare, accessibility of cactus to such laboratory, and availability of rapid transportation to the port of departure, San Francisco. Uvalde, fulfilling these conditions most satisfactorily, was chosen as the future seat of operations in securing the bulk of the Texas cactus-insect complex.

Most valuable were the series of conferences extending over several days, held with the late Mr. J. D. Mitchell at his home in Victoria, Texas. Many hints relating to the various cactus insects, drawn from Mr. Mitchell's previous extensive observations on this group, proved a great help later.

Organization

During the first half-year period, the writer was assisted by a boy for three months. Later, Mr. E. Mortensen was secured as Assistant Entomologist. During the last year and a quarter of the period under discussion the force consisted only of Mr. Mortensen and boy help. Through the kindness of Doctor Hunter the occasional help of Mr. T. C. Barber of the United States Bureau of Entomology was made available. In this way the variety of insects handled at Uvalde was increased by the sending of other species from Brownsville by Mr. Barber.

Equipment

The importation of insects at the laboratories visited in Massachusetts was limited to forms parasitic or predaceous on other insects, and the methods of packing and shipping could not be adapted to use in our problem of sending plant-feeding insects. Furthermore, the period in transit to Australia would occupy from four to five weeks, also entailing the passage through tropical conditions into the southern hemisphere where the organisms would be subjected to directly opposite seasons from those of their native habitat.

Obviously, then, these considerations marked the packing and shipping conditions as a prerequisite to the successful introduction of the cactus insects to Australia. Considerable attention was, therefore,

accorded the designing of shipping cases. The type found to be most suitable is shown in Fig. 1, Pl. 7. This case is a modification of the Wardian case used in shipping nursery stock. Its special features deserve mention here.

The outside dimensions in inches of this case are: length, 40; breadth, 18; height at sides, 15; height at middle, 24. It is put together throughout with screws. Both sides of the top are removable. These tops are fitted on the inner side with brass gauze of 50 meshes to the inch, and exteriorly with "rat wire" of 3 meshes to the inch. These two coverings are separated by the thickness of the frame of the top pieces—about $\frac{1}{8}$ of an inch. Exteriorly, above the rat wire are iron straps at intervals of about 4 inches which clear the protective rat wire by ½ inch, adding further protection to the fine brass gauze. At each end is a beveled-edge door fitted with a cupboard lock, and a ventilator. These parts are covered interiorly and exteriorly with brass gauze. The bottom is provided with two or more small openings to act as drains. They are covered interiorly with brass gauze, and protected exteriorly by squares of galvanized sheeting. The handles project 6 inches beyond either end of the box.

A case of such construction cannot be placed on end by careless transportation employees because of the projecting handles. This type of handle also prevents close packing against the cases of other materials in the express or baggage car, thus insuring ventilation. The doors are serviceable in introducing the insects after the case has been packed and also in allowing the custodian on board the steamer to place water directly on the sphagnum moss in which the cuttings are rooted. The sloping top pieces provide excellent ventilation and allow ample sunlight.

Some of the earlier cases had $\frac{3}{16}$ inch plate glass in the tops instead of the brass gauze, but the latter material is far superior on account of the additional ventilation permitted. All of the later cases were made slightly larger.

This type of shipping cases has proved to be excellently adapted to the requirements of the plants and the insects as well as to the handling methods of transportation employees. They have been used also in shipping insects from point to point in the United States and Australia, and will undoubtedly be used in future sendings from Argentina and Mexico should the Board undertake work there.

The contemplated work successively in various sections of North America demanded the designing of a suitable type of rearing cage

which could readily be dismantled, crated and shipped to the next field headquarters. The standard type decided upon is shown in Figs. 3, 4, Pl. 7.

This cage is 30 inches long by 24 inches deep by 24 inches high. The frame is covered on the inside by a double thickness of that grade of cheese cloth known as sanitary cloth. The tacked edges of cloth are more firmly held down by placing a ½ inch by ½ inch strip over them. This strip is of the same thickness as the lumber in the frames, and is set just one-half inch from the edge of the frame. The cage when assembled is held together by three screws along each corner. The top, fitting snugly into place, rests upon the top half-inch strips of the sides and ends, and needs no fastening. It therefore acts as a door. By virtue of the half-inch strips a three-way fit is secured along each line where one piece of the cage attaches to another.

The cloth of the cage provides ample ventilation and a sufficiency of sunlight. When dismantled each unit part of the cage has its own covering of cloth intact. After crating and shipping, a minimum of time and labor is required to reestablish the cage. The frame is readily recovered with cloth by dismantling, removing the half-inch strips, and later replacing them.

The cage itself has no bottom. It rests upon the earth in a wooden tray which, in turn, is supported by a stool, the legs of which are immersed in cans of water. This expedient safeguards the contents of the cage from the depredations of ants. The cactus is planted in the earth which fills the tray. The frame-cloth cage is securely wired to the tray which holds the earth, effectually preventing overturning by high winds.

This rearing cage was used throughout the North American work and was found by the writer to be equally suitable in Australia. The demountable feature has effected a considerable economy in the North American work.

Small, ventilated wooden cases with screw-on tops were found most useful for posting cactus, bearing fungi and bacterial soft-rot to Australia. They have been of great service also in sending living insects from place to place in the United States and Australia.

Preparation of Material Before Shipment

Preliminary to all actual preparation of material was the collection of the various organisms in the field. This activity necessitated, of course, a simultaneous study of the identities, habits, preferred hosts,

habitats, and degree of injury of all species. The cactus insect bulletin[1] proved an invaluable guide along such lines. All of the principal cactus insects were found in the field, and two new species were discovered.

The work of rearing the field-collected insects free from natural enemies occasioned the devising of methods applicable to each species, and drew heavily upon the knowledge of their life-histories obtained by the observations cited above.

The cactus insects occurring naturally in the field in North America, are, in general, rather heavily handicapped by natural enemies. The procedure followed was to confine the collections of selected species with their host plant in the cloth cages above described. Each species was, of course, collected most readily in certain stages, and by certain methods, the details of which need not be mentioned. Upon appearance of adults, these mature individuals were transferred to another cage containing only clean cactus, and placed under suitable conditions to induce mating and oviposition. The deposition of eggs in perfectly tight cages insured a stock free from enemies. Eggs so laid were collected and placed in other cages where only clean cactus was available. These eggs were the beginning of a parasite-free stock which was shipped either as eggs or in a more favorable stage of development, depending upon the species in question.

It is apparent that the capacity-allotment of field-collected adults to a single cage should normally produce sufficient eggs with which to stock to similar capacity a number of such cages. Experience in rearing taught the number of individuals of a given species which constituted the capacity of the cage. There was derived, then, a rough ratio of expansion in terms of cages from generation to generation for each species. These principles, arrived at by field and laboratory experience, when applied to operations in Australia where the immediate need was expansion, greatly expedited the increasing of the introduced insects.

Since the cottony cochineal insects produce living young instead of laying eggs, and because of the nature of their natural enemies a different procedure was necesasry. Young cochineal crawlers where abundant have a tendency to mass themselves on the topmost spines of the plant on which their parents live. By holding a piece of cheese-cloth beneath such a crowded spine and thumping the spine, the crawlers may be transferred to the cloth without injury. This cloth is then placed in a cage containing cactus which has undergone a most minute examination

[1]The Principal Cactus Insects of the United States, by Hunter, Pratt and Mitchell (U. S. D. A. Bur. Ent. Bull. 113, 1912).

Equipment and Materials Used in Introduction of Cactus Insects
1.—Case used in transoceanic shipment of cactus insects.
2.—Preparation of sphagnum for packing cactus in shipping case.
3.—Interior construction of demountable rearing cage.
4.—Cage assembled.

Stages in Packing of Cactus for Insects Enroute to Australia
(Lower photograph by courtesy of Mr. E. Mortensen).

to free it from all other insects. The crawlers then leave the cloth and settle upon the cactus, starting a culture free from enemies. The edges of doors to cochineal cages must be kept sealed with paper to prevent the entry of any of its many natural enemies.

The volume of insects constantly handled in the insectary was necessarily greatly beyond the requirements of the next consignment. In the first place, several cages of each species were necessary to insure a sufficiency of material in the event that certain cages should become contaminated with natural enemies. Again, since shipments could be forwarded on only one steamer departing at stated intervals, a number of cages of each species in several different stages of development were essential in order to have available the most favorable stage for shipment at the time the consignment was to be forwarded.

In several instances field-collected material was shipped to Australia. This was due, in part, to our inability to give sufficient detailed study to exceptional species while caring for the large stocks above mentioned. Again, such sendings were sometime made to meet the exigencies of the situation as regarded the needs in Australia and the possible termination of the North American work.

The North American force had neither the time nor equipment required to prepare pure cultures of the disease-producing organisms. Consequently, the writer found it necessary to send infected cactus segments or to rely upon the courtesy of several phytopathologists to supply pure cultures for us.

Shipment of Cactus Insects

The great bulk of insects was shipped in the large cases, while small numbers of certain species were sent in the small mailing cases. The latter were, of course, handled as parcel post, there being limited ventilation, no sunlight, and abnormal temperatures.

At the outset the shipping cases were placed partly on deck under outside conditions and partly in that chill-room most remote from the refrigerating machine. The unfavorable results secured from the chill-room portions of the first few shipments sufficed to eliminate that method of shipping.

The packing of various insect species was greatly influenced by their observed tendencies in the field and by the experience gained from rearing them in the insectary. These previous phases of work enabled decisions as to the method of packing the cactus, kind of cactus suitable, stage of insect best adapted to shipment, and number of indi-

viduals which would constitute the capacity of the case for each different species.

Cactus of a nature suited to each particular insect species was carefully selected so as to be free from all insects and diseases (except possibly *Hendersonia opuntiae* which is present on practically every plant in the southwestern cactus area). The presence of cactus anthracnose, for instance, would cause havoc among the cactus plants when passing through the tropics and the reduction of cactus would react against the insects being shipped. It is needless to go into detail regarding these specific points as related to each species, and I will let it suffice to mention one instance of a moth (*Mimorista flavidissimalis* Grote) with a very short life-cycle. This insect feeds only upon the very young, tender joints of cactus ("nopalitos") and reaches the adult stage about 28 days after egg deposition. The insects consigned from the United States to Australia must usually remain in the cases from five to six weeks. In other words, even if shipped as eggs the adults would emerge enroute and would require nopalitos on which to oviposit. Accordingly, cases to contain *Mimorista* were always packed with a sufficiency of nopalitos to insure the development of the eggs or larvae sent, and provision was also made for oviposition of the issuing moths. Old stumps of cactus which have been heavily pruned and have lain unrooted for several weeks, will begin to send out many young joints shortly after being supplied with heat and mositure. Such stumps were also included in cases to contain *Mimorista*, and they made available a fresh supply of nopalitos enroute for oviposition and development of the second brood of larvae.

The number of insects assigned to a given shipping case depended upon the amount of cactus in the case and the relative destructiveness of that particular insect species. It was highly important, then, that every possible piece of cactus be fitted into each case. The clean cactus selected from the field as suitable for a particular species, underwent further selection in the process of fitting together odd-shaped pieces to secure the maximum amount in the case. This selection and close packing of several cases made the preparation of a consignment a most tedious matter. The photographs in Plate 8 show different stages in the packing of cases for *Melitara junctolineella* Hulst and *M. prodenialis* Walker respectively.

To keep the cactus fresh and enable it to root itself enroute a material with high qualities of water retention was needed in which to surround the cut ends of the pieces of cactus. Soil could not be used because of the

danger of introducing to Australia many detrimental soil organisms. Sterilized sphagnum moss was found to fill all needs most excellently. Figure 2, Plate 7 shows sphagnum being prepared for moistening before packing.

By packing as outlined the cases weighed when full about 200 pounds, of which about 140 pounds was cactus.

The consignments of the first eighteen months were sent as excess baggage, and shipments were accompanied to San Francisco and seen properly placed aboard. This procedure, while essential at first, was very expensive. Subsequently the shipments were sent by express, unescorted.

Permission was kindly granted for the shipping cases to be placed on the forward end of the bridge deck of the steamer. Here they were sheltered behind an equipment house which protected them against spray and high waters. They were roped securely in place, and a canopy of canvas protected them from excessive sunlight. The removal of this covering for two hours during the morning and afternoon permitted the entry of sufficient sunlight.

Success in establishing North American insects in Australia was found to depend to a marked extent upon the time of year when the shipment was forwarded. Consignments sent in summer or winter are immediately subjected to reversed seasons upon arrival in the southern hemisphere, and this change renders establishment more difficult. It would appear, then, that shipment during the change of seasons would be most satisfactory since these changes are simultaneous in the northern and southern hemispheres. In other words, a given generation having passed through an American summer would, by shipment in the fall, continue through the summer conditions in the tropics and reach Australia at the beginning of the Australian summer, thus experiencing a continuance of unchanging seasons. This expedient of prolonging the American season does not hold for consignments dispatched in the spring because the winter conditions cannot be prolonged by virtue of the necessity of passing through the tropics. That this line of reasoning is correct is evidenced by the greater success attendant upon fall shipments than spring shipments. The most favorable period of shipment from the southern United States to lands across the equator extends from September to December. Shipment before September allows a touch of winter upon arrival in Australia, while shipment after December usually allows the same at this end.

Upon arrival at Sydney all consignments were met by a member of the Board's staff and escorted on the mail train to Brisbane.

Extent and Nature of Operations in North America

During the work in North America, Uvalde and Brownsville, Texas and Miami, Florida have served as field headquarters. Natural enemies sent by co-workers from Arizona, California, New York, and northern Florida have also been handled at one or more of the above temporary laboratories. Aside from these areas, other regions of the continent have been scouted for cactus enemies and deserve mention here.

During early spring a ten-day period was spent in inspecting cactus in the vicinity of Los Angeles, California. Nothing of special import was found.

During the summer of 1922 the writer spent a fortnight in inspecting southern Arizona and the State of Sonora, Mexico. Little prickly-pear was found, and *Moneilema*, *Narnia*, cochineal, and *Chelinidea* were the principal insects encountered. The *Chelinidea* bug proved new to science.

The urgent need of exact information regarding the cactus insects of Mexico led to more extensive field examinations during November, 1923. The writer and Mr. E. Mortensen visited the following points: Monterrey, San Luis Potosi, Mexico City, San Juan de Teotihuacan, Tepepam, Tlalpam, Guajamalpa, San Angel, and Cuernavaca. Mr. Mortensen later visited Tampico and Victoria in the State of Tamaulipas. The findings are worthy of brief discussion. The box of collected specimens posted to Brownsville, Texas was greatly delayed, and upon receipt larval specimens were in such poor condition that they soon died. They must therefore be referred to without scientific names.

At Tepepam, D. F., on November 13 the writer collected reddish lepidopterous larvae feeding gregariously in prickly-pear. A single larva of like kind was also taken by the writer at Cuernavaca, Mor.

On November 13 near Tlalpam, D. F., the writer found small lepidopterous larvae feeding gregariously within the terminal joints of a tomentose prickly-pear. The larvae were whitish with black spots above. From 25 to 50 individuals lived in close proximity within a small cavity. Excrement in pellet form was pushed through several small holes to the exterior where it collected in a light web and obscured the entrance holes.

Mr. E. Mortensen found at Guajamalpa, D. F., on November 19 white lepidopterous larvae living gregariously within a thick-jointed

prickly-pear. They did not inhabit the terminal joints and the pear exhibited little external evidence of their presence. Some 6 to 8 larvae inhabited the same cavity. The writer is of the opinion that this is probably a distinct species, related to the preceding one taken at Tlalpam.

Near Cuernavaca, Mr. E. Mortensen collected a single adult of *Cactophagus spinolae* on prickly-pear. Larval injury, presumably by larvae of this weevil, was also noted by Mr. Mortensen at Guajamalpa, D. F. on November 19. On the same date between San Angel and Coyoacan Mr. Mortensen and the writer discovered larvae, undoubtedly of this weevil, tunnelling in heavy middle joints of prickly-pear.

On November 10 the cactus collection in Chapultepec Park, Mexico City was inspected. The writer found a cochineal on *Opuntia tomentosa*.

At Tampico, Tams. Mr. Mortensen discovered lepidopterous larvae similar in appearance to *Mimorista flavidissimalis* Grote but differing from that species in habits.

On November 5 at Santa Catarina near Monterrey, N. L., the writer found bluish-gray larvae living internally in an Opuntia of the *Imbricatae* group.

On the same occasion Mr. Mortensen collected yellow weevil grubs in the distal ends of the same cactus.

In addition to the above insects, many of the species common to the Texas cactus country were seen. *Moneilema* beetles, apparently of many species not occurring in the United States, were found in relative abundance in practically all regions visited.

The first four insects mentioned above would undoubtedly prove of great assistance in bringing about biological control of prickly-pear in Australia. It is noteworthy that all of these occur within easy working distance of Mexico City, where transportation facilities are best. Inspection of the region during summer would probably bring to light other species which were not found during this winter survey.

Cactus-Enemy Complexes

Each cactus region of North America has a combination of natural enemies which tend to hold prickly-pear in subjugation. Most important among these natural enemies are the cactus insects, fungi, and bacteria. These natural complexes vary greatly in different regions of North America.

The subjugation of cactus in North America is not due to the action

of any one insect, one particular fungus, etc., but results from the combined effects of the natural enemies of the plant. In planning the biological control of prickly-pear in Australia we should, then, contemplate the establishment there of as large a percentage as possible of the complexes as they exist in America.

The cactus-enemy complex of Florida is quite different from that of Texas. In the latter region insects are more important than fungous diseases of cactus, while in Florida the fungi are much more numerous. Furthermore, there are wide variations in the cactus insects of the Uvalde and Brownsville regions in Texas. These three regions have been the principal contributors to the complex established in Australia. A cochineal from Arizona has also been included.

The various complexes of the United States are necessary in order to provide combinations of cactus enemies for the different climatic regions in Australia. To superimpose upon the United States complex the complexes of Mexico and South America would greatly enhance the chances of expeditious control of prickly-pear.

Consignments and Numbers of Insects Sent

During the period under discussion eleven consignments, totaling 111 cases were forwarded from the United States. Some species were not included in all consignments because they were not always ready for shipment when the S. S. Sonoma departed. The data pertaining to the various species are shown in the following table:

Table Showing Origin, Times Sent, and Number of Individual Insects Shipped

Melitara prodenialis	Fla.	7	5615
Melitara junctolineella	Tex.	8	2077
Mimorista flavidissimalis	Tex.	8	660
Moneilema sp.	Tex.	6	705
Chelinidea vittiger subsp. *aequoris*	Tex.	8	1897
Chelinidea vittiger subsp. *aequoris* var. *artuatra*	Fla.	6	1713
Chelinidea tabulata	Tex.	7	1151
Chelinidea canyona	Tex.	7	1326
Narnia pallidicornis	Tex.	5	1302
Asphondylia opuntiae	Tex.	6	14950[2]
Noctuelia elautalis	Tex.	4	350
Dactylopius tomentosus	Tex.	7	Several infested joints
Dactylopius confusus	Fla.	5	"
Dactylopius tomentosus	Ariz.	3	"
Dactylopius tomentosus	Calif.	1	"

[2]Estimated on basis of 10 maggots to each infested tuna.

Gerstaeckeria spp.	Tex.	4	2077
Scavenging flies	Tex. & Fla.	10	Very large number

A few insects sent have not been included in the above table. One of these was referred to in reports as *Melitara* (*dentata*?), but was later identified by Doctor H. G. Dyar of the United States National Museum as *Melitara prodenialis* Walker. I have not included this insect in the table because it was sent only once and later died out. *Disonycha varicornis* Horn was also sent in small numbers but it was not reared because it feeds on a different type of cactus from any of the Australian ones.

Pathogenic Organisms Sent

The pathogenic organisms sent from Florida include the following: (1) a bacterial soft-rot, (2) common anthracnose (*Gloeosporium lunatum*), (3) zone spot anthracnose (*Gloeosporium cactorum*), (4) *Colletotrichum* sp., (5) *Phyllosticta concava*, (6) "pseudo-Hendersonia," (7) *Phoma* sp., and (8) *Perisporium wrightii*.

Those sent from Texas are: (1) *Gloeosporium lunatum*, (2) *Hendersonia opuntiae*, (3) "white scab," and (4) *Perisporium wrightii*.

Adequate provision for the efficient carrying out of the pathological phase of the prickly-pear project has not been possible in connection with the entomological work. This field is, however, full of promise and deserves the attention of an expert phytopathologist.

Accomplishments

The insects selected for introduction from the United States include 16 species which feed upon healthy pear, and 7 scavenging species which assist the plant feeders by extending the initial injury. All of these insects have reached Australia alive.

None of the scavenging flies have been established due to inability of both Australian and American laboratories to rear them in captivity. Several Australian flies promise to fill the place of the American scavenging flies in the cactus-insect complex. At any rate, an attempt to establish the American scavenging flies should be made subsequent to the establishment in the Australian field of the primary cactus insects.

Of the 16 primary cactus feeders, the midge (*Asphondylia*) and the fruit-worm(*Noctuelia*) have failed to breed in captivity. The four *Gerstaeckeria* weevils have been eliminated on account of their unimportant injury. The available effectives were further reduced by the failure of one cochineal (*Dactylopius confusus* Ckll.) to feed upon the

common Australian pest pears. Of the nine remaining species available, six species have increased in a satisfactory manner.

It is obvious, in view of the above facts and figures, that almost the entire present Australian effort relating to biological control of the prickly-pear pest is based upon the field and laboratory work in the United States. Considering the territory covered and the results achieved in forty months at an annual cost of three-tenths of the yearly appropriation, the whole operation in North America assumes an aspect of strict economy.

The North American work is planned to cease in May or June, 1924. Provision should immediately be made to enable the Board to secure from Mexico and South America other valuable cactus destroyers. By such action several other natural enemies of pear would be rendered available to strengthen the reduced complex already introduced from North America.

THE EFFECT OF DEFICIENCY AND EXCESS IN RAINFALL UPON THE HICKORY BARK BEETLE

(*Eccoptogaster quadrispinosus* Say)

By M. W. Blackman, *New York State College of Forestry, Syracuse, N. Y.*

Abstract

An epidemic of the Hickory Bark-Beetle started in Syracuse in 1912 and has extended to the present time, with a decided checking in 1915. This was preceded by semi-drought conditions over a period of several years before the epidemic started. While the trees were undoubtedly affected, as is shown by a study of the rings of growth, the indirect effect through the lessening of the vitality of the trees is not sufficient to account for all the phenomena. The greatest effect was the more direct one upon the insects themselves, as the deficiency came during the summer months. A deficiency at this time is beneficial to both adults and larvae, and an excess, as in 1915, acts as a distinct check. When the adults are active, continued rain kills many while feeding and establishing their burrows and also checks egg-laying. Excess rainfall, humidity and cloudiness kills the larvae because it produces an excess of water in the plant tissues and this is set free into the larval mines. Deficiency in rainfall has a beneficial effect upon both adults and larvae. This may be put to practical use. If it is known that there has been a deficiency in rainfall extending over several years, an intelligent lookout can be made for the first signs of undue increase of dangerous forms and these can be controlled before they reach epidemic proportions.

For many years there has been a general feeling among forest entomologists that there is a more or less direct relation between drought conditions and the incidence of epidemics of insects—especially of boring insects. As a usual thing this feeling has been suggested or hinted at as

a tentative hypothesis supported if at all by only general observations. One attempt to correlate such an insect epidemic with a deficiency in rainfall was made by Felt (1914).[1] He shows that an outbreak of the hickory bark-beetle began in the vicinity of New York City in 1908 and continued during the following four years. By a study of the Weather Bureau records for that locality he shows that: "From 1906 to 1912 inclusive, there has been a deficient rainfall, except for 1907 at which time there was an excess of only half an inch. The total deficiency during this period amounted to 28.56 inches." More significant still Felt shows that the deficiency in rainfall occurred mostly from June to September "During the growing months and at times most likely to affect vegetation adversely." In conclusion he states: "With the above facts in mind it seems reasonable to believe that these unfavorable climatic conditions may have reacted upon the trees, reducing their normal resistance considerably and resulting in conditions which were extremely favorable to the multiplication of bark borers."

The observations and deductions of Dr. Felt were very interesting to the writer for at the time they appeared he had under observation at Syracuse a similar epidemic infestation of the same bark-beetle. These observations have been continued during the last eleven years, 1913–1923, and the data collected furnishes the basis for some rather interesting hypothetical deductions. These deductions are based not only on a general study of the development and history of the infestation and a correlation of this history with meteorological data, but also takes into consideration the habits of the beetles during their larval and adult life, correlating this with weather conditions. The present writer also attempts to consider the physiological condition of the tree under different degrees of rainfall and the effect of these different conditions upon the attack of bark-borers. The deductions drawn are not presented as proven facts, but are offered as a working hypothesis which may serve to stimulate future intensive investigations upon the interrelations between climatic conditions and the development and control of bark-beetle infestations.

The infestation of the hickory bark-beetle at Syracuse was first observed by the writer in September 1913. It occurred in a pasture woodlot of nearly four acres. The sparse stand, clay soil, steep slope, close pasturing and absence of underbrush made the conditions of growth quite unfavorable for hickory. In all there were about 165

[1]Felt, E. P., 1914. Notes on Forest Insects. Journ. Econ. Ent. Vol. 7, pp. 373–375.

hickories in the grove. About a dozen trees had been attacked and killed during the summer (1913) and a number more were infested and partly killed. Several trees were also found which had been killed the preceding year. All of these killed trees were in one corner of the hickory grove and none of the trees showed the effect of the brood except in this one corner. No trees killed by the hickory bark beetle were found near Syracuse except in this one spot, although beetles were found in various places in felled trees and in broken branches.

During the following year (1914) 111 hickories in the grove of less than four acres were killed—76 per cent of those still alive the preceding fall. That summer there was little tendency in the way of dispersal of the epidemic shown. It is true that perhaps a half dozen outlying pasture trees were attacked and killed but none of these were more than a hundred yards from the main group. This of course is easily explained by the abundance of the proper host close at hand.

In the summer of 1915 thirty of the thirty-five remaining hickories in the woodlot were killed by the beetles and in addition to these four trees some half mile away were also killed. These thirty-four hickories were the only ones found within a radius of one and a half miles to succumb this year. Had the injuries increased in the same proportion as in the preceding year, close to a thousand trees would have been killed in the summer of 1915. There can be no doubt that this year there was a very decided decrease in the injuries resulting in a partial control of the epidemic. The explanation of this will be attempted later in this article.

The later history of the epidemic will be given in general terms only because as the beetle spread farther and farther from the original focus of infestation it became increasingly difficult to keep specific data. In 1916 the trees killed by the beetles in the area under observation were about as numerous as those of the preceding year but were distributed over a much wider area. Several trees in a wood lot a half mile south were attacked and killed and the tops of others were deadened. In an easterly and northerly direction the effects of the beetles were seen for about a mile and a half—the killed trees being mostly isolated hickories in pastures. In the several years following there was a progressive increase in the injury and a rapid spread, especially toward the north and east in the direction of the drive of the prevailing summer winds. By 1922 a great per cent of the hickories, especially pasture and roadside trees, had died at least as far east as Canastota (about 20 miles). Appearances all point toward a progressive spread from the original focus at Syracuse. On account of the absence of specific data, however, it is not

possible to be sure that beetles from several such foci of infection may not have combined.

The main facts of the history of this infestation to be emphasized and to be remembered in connection with the attempted explanation following are as follows:—(1) The consistantly rapid increase of the number of the hickory bark-beetle (as shown by the number of trees killed) from 1912—1914 inclusive; (2) the sharp reduction in the numbers of the beetles in 1915; (3) the lack of any marked increase or decrease in 1916; (4) the steady but gradual increase and diffusion of the insects from 1917 to the present time.

In the table given herewith the precipitation departures at Syracuse for each month of the years 1908 to 1922 inclusive is shown. By consulting this table it will be readily seen that there was an annual deficiency in rainfall for every year from 1908—1913 inclusive, a slight excess in 1914 and an excess of 10.24 inches in 1915. The total deficiency from 1908 to 1914 inclusive was 23.58 inches. A closer scrutiny of the data will show that much of this deficiency came during the three growing months of the tree—June, July and August.

An examination of the growth rings of thirty trees killed during the five years from 1912 to 1916 was made. A great diversity of conditions were found but these may be briefly recorded as follows. Of two trees killed in 1912 (the year of the incidence of the infestation in the wood lot studied) one showed very slow growth for a period of more than 20 years before its being killed, while the other, closely adjacent to it, showed normal growth up till 1908 with but a slight reduction from 1908—1912. Of five trees killed in 1913 two showed moderate reduction in the rings from 1908 to the time of their death, two showed similar reduction in growth from 1909, and one showed slight reduction from 1906—1908, an increase in 1909 and slight reduction from then till its death. Trees killed during 1914 and 1915 showed the same variable conditions. In some the reduction in the rings was never excessive while in others it was very great. In some the reduction in growth extended back many years, while in others it did not begin until 1910 or 1911. It is certain from this data that the deficiency in moisture extending over a period of several years has a decided effect upon the amount of new wood laid down by the tree. This effect is shown in some trees by an immediate and sharp reduction in the width of the growth rings, in others by a gradual reduction increasingly marked each year, while in other trees no effect is apparent until the deficiency has continued for several years. When the facts are all considered there can

PRECIPITATION DEPARTURES AT SYRACUSE

(U. S. Weather Bureau)

1908–1922

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1908	+0.08	+0.43	+0.17	+1.02	+0.10	—1.11	0.00	—2.67	—2.00	—0.48	—1.73	—1.20	—7.38
1909	+0.86	+2.75	—0.92	+0.78	—0.55	—1.64	———	———	—1.14	—1.96	—1.41	—0.89	—4.06
1910	+0.33	+1.84	—1.75	—0.92	+1.37	—1.65	—0.72	—0.06	+0.48	—1.68	—0.52	—0.41	—3.69
1911	—0.03	+0.86	+0.33	—0.28	—1.18	—0.67	—0.62	—0.88	—0.06	—1.05	—1.21	+0.98	—3.81
1912	—0.61	+0.25	+0.96	+1.35	—0.17	—3.34	—0.52	—0.36	+2.77	—1.54	+0.25	—0.75	—1.71
1913	+1.66	———	+2.46	—0.30	—0.60	—1.79	—2.73	—1.17	—0.95	—0.08	—0.67	—0.25	—4.42
1914	+0.41	+0.62	+1.96	+1.96	—0.34	+0.51	—1.04	+1.90	—1.35	—2.00	—1.65	+0.51	+1.49
1915	+2.55	+1.05	—1.27	—1.52	—1.37	—0.42	+3.69	+2.12	+2.29	+1.19	—0.49	+2.42	+10.24
1916	—0.14	+2.13	+0.98	—0.34	+0.48	+1.23	—2.72	+0.09	+1.30	—1.77	—0.70	+0.21	+0.75
1917	+0.31	+0.93	+0.04	—0.04	+0.26	+0.57	—1.88	—0.45	—1.32	+1.46	—1.79	+1.38	—0.53
1918	+1.46	+0.22	—0.52	+0.38	+0.00	+0.33	—1.46	—1.88	+1.52	+0.35	—1.52	—0.39	—1.51
1919	—0.05	—0.21	+1.92	+1.49	+1.52	—2.30	+1.76	—1.33	—1.22	+0.48	—0.70	—0.41	+0.95
1920	+1.52	+0.02	+0.34	+0.88	—3.20	—2.35	+0.14	—0.75	+3.80	—2.53	—1.54	+0.73	+0.14
1921	—1.12	+0.67	+0.54	+0.59	—1.12	—0.06	+0.76	—0.94	—1.27	—0.11	+3.88	—1.70	+0.12
1922	+1.40	+1.03	+2.30	+0.16	+0.45	+12.03	—1.29	+1.54	—1.51	—0.96	—1.47	+0.19	+13.87

be little doubt that the continued deficiency results in a considerable but variable reduction in the vitality of the tree and increases (either much or little depending upon the individual tree) its susceptability to destruction by the bark-beetles. On May 7, 1924, increments were taken of ten living hickory trees growing under more healthy conditions in a woodlot about 2 miles south of the original center of infestation. Here there was no evidence of present or past activity of the hickory bark-beetle. The increments showed considerable individual variation but the average condition as compiled from the ten trees is as follows:—a gradual decrease in the increment from 2.2 mm. in 1907 to 1.5 mm. in 1914; an increase to 1.7 mm. in 1915; and again a decrease to 1.1 mm. in 1923.

In the view of the writer, after considering all of the data given and other data appearing later, the weakened condition of the tree is not sufficient fully to account for the rapid increase in the number of the insects and the resulting increase in the trees killed. It would seem, however, that an abnormality in precipitation during the months of June, July and August would have a decided direct effect upon the insects themselves—either favorably or adversely. It is believed that this direct effect would be of more importance in fostering an epidemic and certainly of greater importance in checking one than would be the indirect effect upon insects as exerted through its influence on the health of the tree. That any deficiency or any excess in rainfall during the three months period or any excess of cloudiness during the latter part of it would have an effect upon the beetles or their younger stages can be understood better when we consider the habits and seasonal history of the bark-beetle.

The hickory bark-beetle passes the winter as a fully grown larva in the outer portion of the inner bark of its host tree. The adult beetles emerge at Syracuse during the latter part of June, throughout the month of July and during early August. The height of emergence usually occurs during the first two weeks in July, but varies somewhat according to the advancement of the season. The adults fly at once to living hickory trees and feed for some time by boring into the young twigs and into the bases of the leaf-petioles. After feeding for some time—exactly how long is not known—the beetles fly to the trunk and branches where they may often be seen in hundreds creeping over the bark and examining every crack and crevice. Each female selects some place where the bark is thin, as in one of the longitudinal cracks, or under one of the loosened scales, and begins to construct her burrow. The entrance tunnel extends through the bark at a slightly upward angle and

when the surface of the sapwood is reached is continued longitudinally upward as the egg-gallery. After being fertilized the female beetle continues extending the egg-gallery. At each side she gouges out small niches, in each of which a single egg is deposited. In this process the beetle extends the gallery with her mouth parts. When it has been carried slightly beyond the last egg-niche she constructs another niche. Then in order to deposit the egg it is necessary that she back out of the burrow to the surface of the bark, reverse herself and re-enter the burrow

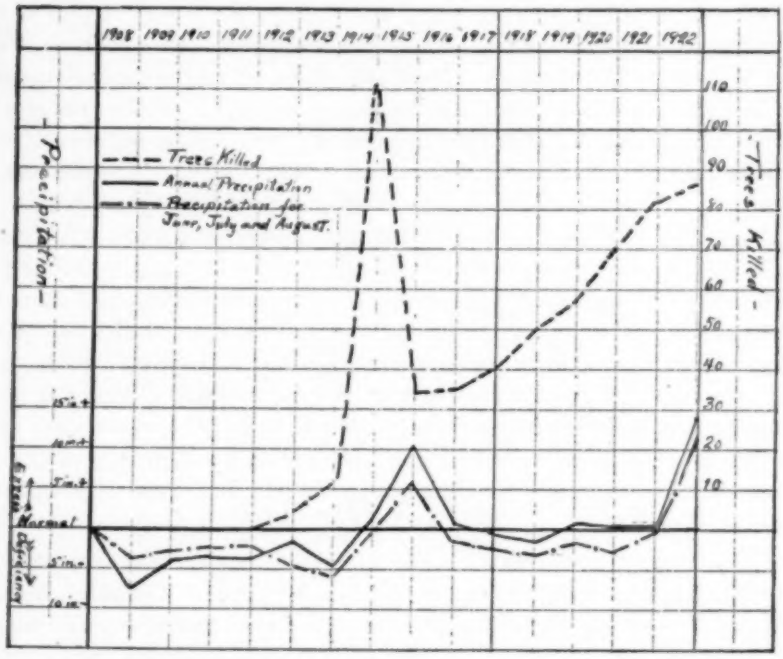

FIG. 11.—Graphs showing excess and deficiency in precipitation at Syracuse from 1908–1922 and relation to injury by the hickory bark-beetle. The rather close paralelling of the graph showing annual precipitation and that showing the conditions for the three growing months (June, July and August) is interesting in demonstrating that most of the departure from normal came during these three months. Also note that the incidence of the epidemic came on the year when the deficiency in precipitation for the growing months became greater than for the entire year. Note also that from this point on the graph representing the departures during the Summer months remains well below that representing the departures for the year—i. e. the deficiency is always greater and the excess always smaller, there being an excess only in 1915 and 1922. The effect of the excess in 1922 was slight as it was due to two very heavy rains occurring rather early in June. The graph showing "Trees Killed" is based on actual counts from 1912–1918. After that the number killed is estimated, due to the wide spreading of the epidemic from its place of incidence.

backward. When the egg is placed in the niche she creeps out of the burrow, turns around and enters it head first, packs the egg with frass and resumes her burrowing.

Such being the habits of the adult beetles it is, I think, very evident that a deficiency in rainfall during the time when they are on the wing, feeding on the leaf petioles, starting their brood galleries and laying the eggs, would be very much to their advantage. Conversely, an excess in precipitation at these times would result in the destruction of many of them. A deficiency in rainfall during late June and throughout July would work very much to the advantage of the beetles and an excess during this time would have the reverse effect. Departures from the normal during July—especially during the first half of the month, would be of greatest importance in their direct effect upon the adults. By consulting the accompanying table it will be seen that from 1908 to 1913 inclusive there was each year a deficiency in precipitation during the month of June. In July—the most important month in its effect upon the adult beetles—the deficiency in rainfall extended from 1908 to 1914 inclusive.

But it is the opinion of the writer that rainfall not only exerts this direct influence upon the adult beetles, but also, through the effect of excess or deficiency upon the physiological processes of the tree, exerts a perhaps greater effect upon both adults and larvae. A deficiency in rainfall would mean a lessened amount of moisture in the soil available for absorption by the root hairs. Such a deficiency also would be accompanied as a rule by a greater amount of sunshine and a decreased amount of humidity in the atmosphere. Thus at such times there would not only be a lessened amount of moisture available to the tree, but there would be an increased loss of moisture due to more rapid evaporation from the leaf surface. This would result in a lessening of the moisture content of the tissues of the tree and a decrease in the sap-pressure. It has been established by recent investigations of McDougal by means of the dendrograph, that during periods of sunshine when the loss of evaporation through the leaf surface is greatest, there is an actual measurable decrease in the diameter of a living tree, and conversely during periods of cloudiness an actual increase in the diameter. This can only mean that the effect of the cloudy weather is an excess in the moisture content of the tree, resulting in a swelling or turgidity of its component living tissues. Thus an insect, such as either the adult or larva of the hickory bark-beetle, boring through the living tissues of a tree would in wet cloudy weather release into its burrow a much greater

amount of water than it would under like conditions in a dry period of much sunshine.

Perhaps the most conclusive evidence of the influence of these several factors upon the bark beetles is furnished by the decided checking of their injuries due to the excess in rainfall during July and August in 1915. Corroborative evidence of the opposite effect of a deficiency in precipitation is, however, furnished by the development of the epidemic from 1912–1914 inclusive and by the renewed increase in damages in the years following 1915 when a deficiency again became evident. As will be seen by referring to the table, the first six months of 1915 showed a slight deficiency in precipitation so that the trees were in no better condition as to stored-up resistance than in previous years. In the second half of the year, however, there was an excess of 11.22 inches and of this excess more than half came in the months of July and August when the effect upon the beetles and their larvae would be greatest. As has already been stated, only 34 trees were killed, although the previous year 111 had suffered mortal injury. As we have already seen the reason for this could not have been due to the condition of the trees at the time the beetles emerged from their old hosts and there can be no reasonable doubt that the partial control if due to weather conditions was due to such as existed after their emergence.

The rainfall in July was 3.69 inches above the normal for the month. There was rainfall on 19 days and 21 days were cloudy or partly cloudy. In the first half of the month 10 days showed rainfall varying from .01 to 2.63 inches. This is the period when the adults are emerging and feeding upon the twigs and petioles—when they are most exposed to injury. In August the excess precipitation was 2.12 inches. Rain fell on 19 days, there being 11 rains during the first 15 days. There were but 3 clear days and of the remaining 28 days (cloudy or partly cloudy), 13 are listed as cloudy. This is the period when excess of precipitation, especially when accompanied by a greater amount of cloudiness than normal, would if our deductions are correct, cause a greater sap-pressure in the tree and in this way check the work of both adults and larvae boring in the living tissues.

At the time, the writer did not fully realize the significance of what was occurring and the observations made were not as detailed and systematic as would be desired. However, in September a number of trees—including not only those killed but also a large number not mortally injured—were examined. The most striking fact with regard to the killed trees was that the brood galleries were much shorter than

normally and as there is a fairly definite relation between the length of the gallery and the number of eggs deposited, a smaller number of progeny came from each pair than is normal. In addition to the trees killed this year many others were attacked but were not killed. In these, many burrows were started only to be abandoned before a single egg was laid. In other burrows a few eggs had been laid but did not hatch. In still others the egg-gallery had been continued for a distance of one or two centimeters upon the sapwood, eggs had been laid in niches on each side and the young larvae hatching from them had started their mines at right angles to the egg-gallery. However, in most of the burrows, either all or a greater number of the larvae had soon succumbed. Thus while many trees were attacked by the beetles in numbers sufficient, under normal conditions to have insured their death, only four trees outside of the immediate center of infestation were killed. The flight of the beetles in a northerly direction could be readily traced for more than a mile by the presence of aborted brood burrows in the trees attacked.

The writer explains these various facts as follows. The frequent rains during the first half of July destroyed a number of the adults while these were feeding upon the twigs and petioles. However, a considerable number of these survived in spite of the adverse conditions at this time and the continued excess in rainfall during the following month. Many of these beetles attacked the trees in swarms, and started their burrows. Where the beetles were present in excessively large numbers, their attack was successful and the trees were killed. Those emerging later, however, found practically all of the trees in the vicinity already fully stocked and were forced to migrate. Dozens of pasture hickories were attacked during late July and August but this was successful on only four trees. We have already seen that there was an excess in rainfall during August and—which is of at least equal importance—this month was excessively cloudy, there being only three clear days. The result of this was an excess of sap held in the living tissue of the tree—an increase in sap-pressure. Thus the adult in making the brood burrow was subjected to an excessive flow of moisture into her burrow and this moisture on account of the cloudy and humid conditions did not evaporate from the burrow entrance as rapidly as normally. Also during the frequent rainstorms the female was twice subjected to the danger of being washed away for every egg deposited. Doubtless also many females were never fertilized on account of the high mortality of the males, which remain outside of the burrows most of the time. Thus the

results were as follows. In many cases the burrow was started but was abandoned before eggs were laid. In other cases the egg-galleries were continued for some distance, although always short and a few eggs were laid. The larvae hatching from the eggs were for the most part soon overcome by the excessive amount of moisture set free into their burrows as these were excavated by the larvae. The mortality of the adults and larvae in the later burrows was much heavier than in those started during July because of the greater saturation of the soil, the greater amount of cloudiness and the consequently greater excess of water in the plant tissues.

If the truth of the hypothesis advanced should be established by future detailed and systematic observations, of what practical use would it be to forestry? To the writer it seems that it promises to be of great practical value. While it is manifestly impossible for man to so change climatic conditions as to control an infestation once thoroughly established, a thorough knowledge of the causes underlying the development of a bark-beetle epidemic and a full appreciation of the factors favoring the incidence of such outbreaks, will give to those responsible for the protection of the forests the ability to foresee a possible epidemic before this has really started. Thus, if it is known that a period of deficiency in rainfall at certain seasons weakens the resistance of trees to attack and at the same time favors the development of certain tree destroyers, an intelligent lookout may be made for the first signs of an undue increase in the known destructive agencies and these can be controlled by means of already known methods long before the infestation reaches epidemic proportions.

Even when, as is often the case, the meterological data for a given locality is lacking, there would seem to be an excellent chance of detecting adverse conditions due to a deficiency in rainfall or to other influencing factors, by a systematic study of increment borings. If a majority of these show a marked lessening of increment growth over a period of several years, an especial attempt may be made to detect a developing infestation before it becomes epidemic. Such an incipient outbreak can then be controlled before it becomes serious and thus prevent great possible damage. In other words, if taken in time prophylactic measures may be used rather than remedial measures.

THE SOLUBILITY OF ARSENATE OF LEAD IN THE DIGESTIVE FLUIDS OF THE HONEY BEE[1]

(*Apis mellifica*)

By HARRISON M. TIETZ

ABSTRACT

The purpose of this study was to find out how the solubility of arsenate of lead is increased by the action of the digestive fluids present in the alimentary tract of an insect. In making these determinations, the honey bee, *Apis mellifica* Linn., was taken as the insect and the solubility of arsenate of lead powder in water was taken as the unit of solubility. The conclusions drawn from this experiment are as follows, (1) The solubility of arsenate of lead does not seem to increase when the powder is acted upon by the fluids in the oesophagus. (2) The digestive secretions of the honey stomach and stomach render the poison at least one and one quarter times as soluble. (3) The action of the intestinal juices is to throw at least three and three quarters times as much of the powder in solution as would be dissolved by water alone.

In order that a poison may be absorbed by the body and so cause death, it is necessary that it should be in a soluble form. When arsenate of lead is taken into the alimentary tract of an insect, it is very insoluble. When we realize that the average arsenate of lead powder contains but 32% arsenic pentoxide, and that the insect consumes but a small quantity of the spray mixture, we can readily believe that the solubility must increase when the powder comes in contact with the digestive fluids in the alimentary tract, otherwise the quantity of arsenic capable of assimilation would be so small that the insect would be unharmed by its presence in the blood. It is the aim of this paper to show that arsenate of lead becomes more soluble when acted upon by the digestive fluids.

Before entering upon a discussion of methods and results, the writer wishes to state that his findings are merely indications of what may take place in the insect's body. In the alimentary tract of the living animal, the percentage of solubility may be even greater than the percentages obtained from the writer's experiments. This is true for two reasons. In order to get a sufficient quantity of liquid with which to work, it was necessary to dilute the gastric fluids. The more concentrated digestive fluid, to be found in the living animal, may have the power to throw more of the arsenate of lead in solution. Another factor to be considered is that the alimentary tract while it remains in the living insect may continue to secrete gastric fluids and so produce larger quantities of the solvent resulting in more arsenate of lead being dissolved. When, how-

[1]Contribution from the Entomological Laboratory of the Mass. Agricultural College, Amherst, Mass.

ever, the digestive tract is dissected from the insect, the cells die and so do not produce as much of the solvent.

Determination of the Hydrogen ion Concentration

Since the reactions (acidity or alkalinity) of the various portions of the alimentary tract play an important part in determining how much arsenate of lead will be dissolved, the writer first determined the hydrogen ion concentrations of the various portions of the digestive tract. These portions were as follows—(1) the oesophagus, (2) the honey stomach plus the stomach, and (3) the remainder of the alimentary tract. The divisions were made in this manner because these portions are more or less shut off from their neighboring sections, while there is free communication for the gastric juices within the portions themselves.

The determinations were made as follows. Twenty-four bees were killed with chloroform and immediately dissected. The oesophagi of these bees were removed and placed in 12 c.c. of neutral water (Ph + 7). The honey stomach and stomach were treated in a similar manner and placed in a second flask containing 12 c.c. of the neutral water. The remainders of the alimentary tracts were placed in a third flask also containing 12 c.c. of the neutral water. At the end of an hour a sample was taken from each flask and tested with Phenol Red, Methyl Red and electrically. The solutions remaining in the flasks were kept 24 hours at about 15 C° and tested again by the same methods. The results of these tests are shown in the following table.

Portions of the Tract	Immediate Reaction	Reaction End of 24 hrs.
Oesophagi	7.0	7.0
Honey stomachs + Stomachs	5.6	5.6
Intestine	7.4	7.4
Neutral Water	7.0	7.0

The second tests were made to see whether the solutions could stand in a cool room 24 hrs. without affecting their reactions. This point is very important, for in making the solubility tests the arsenate of lead was acted upon for 24 hrs. If during this time there was an increase in the acidity or alkalinity due to the decomposition of the tissues, then the solubility would be greater than under normal conditions and so give misleading results. As the table shows there was no change in the Ph + at the end of the 24 hrs.

Solubility Tests

In making the solubility tests, twenty bees were chloroformed, im-

mediately dissected and their alimentary tracts divided into three portions (oesophagi, honey stomachs plus stomachs, and intestines) and each of the portions was placed in 20 c.c. of neutral water. To each flask of water plus its portion of the digestive tracts, was added exactly one gram of arsenate of lead powder, and to 20 c.c. of neutral water alone was also added one gram of the same powder. This last flask was, of course, used as a check. At this point in the experiment, the writer had the choice of two procedures. In the first place, the portions of the alimentary tracts could have been washed for several hours in the neutral water, then filtered off and the arsenate of lead added to the filtrate. The second way was to add the arsenate of lead immediately to the water plus its portions of the alimentary tracts. Both ways have their merits and faults. In adding the arsenate to the filtrates there is the possibility of obtaining not only a solution of the digestive fluids but also, because the portions of the alimentary tracts would have to stand several hours in the neutral water before filtering, the chance of getting into the filtrate the products of cellular decomposition that would effect the results by increasing the solubility of the poison. The second method in which the arsenate is added immediately would prevent the formation of decomposition products for arsenic in the body acts as a preservative. This point has been noted by many writers who have performed autopsies on arsenically poisoned animals.

One bad feature of this latter procedure is that the cells undoubtedly absorb some of the soluble arsenic. The arsenic then, very likely, becomes bound up with the protoplasm itself and so does not pass into the filtrate. In other words the filtrate obtained does not contain the total amount of arsenic rendered soluble by the digestive fluids.

While it was true that the Ph + did not change when the portions stood 24 hrs., the writer chose the latter method in order to feel sure that the arsenate of lead was not being acted upon by the products of putrefaction.

The contents of the flasks were agitated several times, then at the end of 24 hrs. were filtered. The check was treated in the same manner. In filtering, a triple filter was made using Schlucher and Schüle No. 589, 11 cm. paper. The filtrates were re-filtered eight times in order that they should contain nothing but the soluble arsenic i. e., to prevent any undissolved arsenate of lead powder from passing into the final filtrates.

To the four final filtrates, namely, from the three portions of the alimentary tract and the check, was added 5 c.c. of concentrated nitric

acid. This was done in the case of the samples from the alimentary tract to destroy any soluble organic matter that might have passed through the filter paper and which would later hinder the arsenic determinations. It was added to the check to allow for the possibility of arsenic being introduced through the nitric acid itself. After the acid was added the filtrates were evaporated to dryness on a steam bath.

When all the samples had been evaporated to dryness, they were redissolved in 100 c.c. of concentrated HCl, that is to say, 100 c.c. of HCl was added to each sample and also to the check. From this point the standard method for total arsenic determination was employed. In a 500 c.c. distilling flask there was placed 6 grams of cuprous chloride. Then, through a separatory funnel, the 100 c.c. of HCl containing the sample was added and the liquid distilled down to 50 c.c. The flask containing the sample was washed with three more portions of concentrated HCl-50 c. c. in each portion—and these were distilled over after the original 100 c. c. had distilled down to 50 c. c. The final distillate for each sample was 200 c. c., 50 c. c. being left in the distilling flask. The distillate was caught in three flasks packed in ice and the receiving flasks were carefully washed into a large flask so that none of the distilled liquid was lost. Of course, the same procedure was carried on for all three samples and the check. The four distillates were then made up to 1,000 c. c. each, then filtered, and finally made up into 100 c. c. aliquots. The aliquots were neutralized with sodium bicarbonate and to each aliquot was added a small amount, 2 c.c., of starch paste as an indicator. Then the aliquots were titrated against iodine and as soon as a permanent, but faint, blue color was obtained, the quantity of iodine needed to bring about this result was determined. The results of the titration were as follows.

Oesophagus aliquot	No. 1—.11 c. c.
"	No. 2—.10 c. c.
"	No. 3—.11 c. c.
Honey Stomach plus Stomach aliquot	No. 1—.13 c. c.
"	No. 2—.12 c. c.
"	No. 3—.13 c. c.
Intestine aliquot	No. 1—.29 c. c.
"	No. 2—.30 c. c.
"	No. 3—.30 c. c.
Check (water sol.) aliquot	No. 1—.11 c. c.
"	No. 2—.11 c. c.

A blank was also distilled over. This consisted of 250 c. c. of concentrated HCl and 6 grams of cuprous chloride. By distilling over 200 c. c. of this blank, the writer was able to determine the arsenic

present in the reagents. Titrating aliquots of this blank, the results were as follows.—

Blank aliquot ..... No. 1—.04 c. c.
" No. 2—.04 c. c.

The final determinations were:—

Oesophagus	.11	c. c.	minus	.04	c. c.	(blank)	= .07	c. c.	final	reading
H. Stomach +Stomach	.13	"	"	"	"	"	= .09	c. c.	"	"
Intestine	.30	"	"	"	"	"	= .26	c. c.	"	"
Check	.11	"	"	"	"	"	= .07	c. c.	"	"

The next step was to take a standard solution of soluble arsenic and titrate with the same iodine. When this was done, it was found that it took 41.01 c. c. of iodine to neutralize 25 c. c. of this standard solution. Twenty-five c. c. of the standard solution was known to contain .025 grams of As_2O_3, so one cubic centimeter of iodine would neutralize $\frac{.025}{41.01}$ or .000609607 g. of As_2O_3. To find the grams of As_2 multiply the As_2O_3 factor by .75748 and for As_2O_5 multiply the same factor by 1.16168. These factors are based on atomic weights. The final factor for As_2 determination was .00046176511036 grams As_2 for every c.c. of iodine used (.000609607 × .75748) and the grams of As_2O_5 neutralized by every c.c. of iodine was equal to .00070816825976 (.000609607 × 1.16168).

Having made these determinations they were then used in computing the As_2 and As_2O_5 present in the samples and check. These computations were as follows:—

Oesophagus
.07 c. c. iodine × .000461765 = .0000323255 grams As_2 in an aliquot
.07 c. c. iodine × .0007081682 = .000049571774 grams As_2O_5 in an aliquot
Honey Stomach plus Stomach
.09 c. c. iodine × .000461765 = .00004155885 grams As_2 in an aliquot
.09 c. c. iodine × .0007081682 = .0000637335138 grams As_2O_5 in an aliquot
Intestine
.26 c. c. iodine × .000461765 = .0001200589 grams As_2 in an aliquot
.26 c. c. iodine × .0007081682 = .000184123732 grams As_2O_5 in an aliquot
Check
.07 c. c. iodine × .000461765 = .0000323255 grams As_2 in an aliquot
.07 c. c. iodine × .0007081682 = .000049571774 grams As_2O_5 in an aliquot

Since each aliquot was 1/10 of the total amount (100 c. c. of 1,000 c. c.) these results must be multiplied by ten to get the number of grams of As_2 and As_2O_5 rendered soluble by the digestive fluids and the water check. If we wish to reduce the quantities to per cents it is necessary to

divide again by 100 as one gram of powder was introduced into each flask. The final table of solubilities would therefore be:

Oesophagus
As_4—.0003232+ grams or .032%
As_2O_5—.0004957+ grams or .049%
Honey Stomach and Stomach
As_4—.0004155+ grams or .041%
As_2O_5—.0006373+ grams or .063%
Intestine
As_4—.0012005+ grams or .12%
As_2O_5—.0018412+ grams or .184%
Check
As_4—.0003232+ grams or .032%
As_2O_5—.0004957+ grams or .049%
Check (water sol.)

Since the quantities are so minute they are well within the limits of possible error, and must be taken as mere indications of the effect of digestive fluids upon arsenate of lead powder rather than looking upon them as absolutely accurate or fixed quantities. For this reason it would be better to express the solubilities with reference to the water soluble arsenate of lead. Taking this as a unit we have

Check (water sol.)
As_4—.032% =1.00
As_2O_5—.049% =1.00
Oesophagus
As_4—.032% =1.00
As_2O_5—.049% =−1.00
Honey Stomach and Stomach
As_4—.041 =1.28
As_2O_5—.063 =1.28
Intestine
As_4—.120% =3.75
As_2O_5—.184% =3.75

Summary

1. The hydrogen ion concentration of the alimentary tract of the honey bee is as follows:—oesophagus 7.0 (?), stomach plus the honey stomach 5.6, and intestine 7.4.

2. The results of this experiment can only be an indication of what goes on in the insect's body, for in carrying out this work some of the soluble arsenic combined with the cell protoplasm and could not be found in the filtrate. Furthermore, natural conditions could not be simulated so that it is probable that even more arsenic would be rendered soluble by the living insect.

3. Accepting these qualifications we find that the digestive fluids of the oesophagus apparently do not render the arsenate of lead more soluble. (Further investigation should be carried on here). Secondly the digestive fluids of the honey stomach and stomach makes the powder 1.28 times as soluble as it would be in water alone. Thirdly the intestinal fluids increase the solubility 3.75 times what it would be in pure water.

ACKNOWLEDGMENTS

In carrying out this work the writer received many helpful suggestions and material aid from several persons. It was through Prof. Bourne that the writer was able to obtain specimens for dissection. The determination of hydrogen ion concentration by the electrical method was made by Dr. Itano using an apparatus devised by himself. For a fuller description of this device see Bulletin 167 of the Mass. Agricultural Experiment Station on the "Relation of Hydrogen Ion Concentration of Media to the Proteolytic Activity of Bacillus subtilis" by Arao Itano, January 1916.

Dr. Holland kindly granted the use of the experiment station and both he and Mr. Dunbar demonstrated to the writer the methods employed in arsenic determination.

Miss Emma Oetinger very kindly prepared the manuscript for publication.

To all these persons the writer wishes to express his sincerest gratitude.

RESULTS SECURED FROM LATE SEASON APPLICATIONS OF CALCIUM ARSENATE DUST, FOR THE CONTROL OF THE COTTON BOLL WEEVIL

By C. B. NICKELS, *Clemson College, S. C.*

ABSTRACT

The cotton boll weevil (*Anthonomus grandis* Boh.) causes severe damage to late fruiting crops after the beginning of migration. Serious injury did not occur in majority of fields until August 10th or later.

The average increase in yield of seed cotton resulting from the use of calcium arsenate dust on comparable plots was 236 pounds per acre. Average expense of using the calcium arsenate dust method was the cost of 29.27 pounds of calcium arsenate and 3.6 hours of labor.

The experiments discussed in this publication were conducted in the Piedmont Section of South Carolina during 1923. During the season of 1922, also 1923, a high percentage of the injury caused by the weevil,

occurred either within two weeks before migration or after the beginning of migration.

FACTORS INFLUENCING TESTS.—Serious weevil infestation did not occur in the majority of the plots until August 10th, or later. It was necessary to poison only one field used in these tests prior to August 9th. Several plots selected to be used in these tests never required poisoning because the crop matured before weevil injury developed.

The number of poison applications required is determined by the percentage of infestation and the fruiting condition of plants. No applications of poison were made when weevil infestation was low or when the plants were not fruiting.

Cotton on fertile land that continued fruiting over a long period, offered the best opportunity for securing increase in yield, as a result of poisoning. The crop was late in localities, where tests were conducted, affording an excellent opportunity for testing the value of poison applications after the beginning of weevil migration.

SEASONAL PROGRESS OF INFESTATION.—Infestation records were made weekly, throughout the growing season. Before square formation the weevil infestation was determined by counts of the number of weevils per hundred plants. After square formation the weevil infestation was determined by counting the percentage of squares infested. A summary of these records is given in tables 1 and 2. The plots used in these experiments varied in size from three-quarters of an acre to 3½ acres, no poison applications having been made on these plots, prior to the date records were begun. It is believed that these records will indicate, why early poisoning did not usually give profitable results in the localities under consideration.

TABLE 1. PLANT INFESTATION RECORDS

Date	Percentage	Number of Plots examined
June 12	1.19	11
June 18	0.9538	21
June 25	1.23	21
July 3	0.9966	12
July 9	0.7012	8

TABLE 2. SQUARE INFESTATION RECORDS

Date	Percentage	Number of Plots examined
July 9	4.823	7
July 16	3.937	28
July 24	2.876	29
August 1	3.467	24
August 8	2.382	29
August 15	17.656	20
August 22	24.296	13

Thirty-eight plots received no treatment for weevil control prior to August 10th and only four plots developed sufficient infestation to require control methods before that date. Some of the plots from which records are given in the above tables, were used as checks in sweetened poison and proprietary mixture tests.

Table 3, is a record of the percentage of square or bud infestation of the calcium arsenate dust plots.

TABLE 3. SQUARE INFESTATION

Plat No.	July 16	July 24	August 2	August 7	August 15	August 22	August 29	Sept. 6
1	7	11	5	14	33	11	17	28
1 Check	11	8	19	19	54	79	92	100
2	3	1	1	1	4	6	2	5
2 C	2	1	1	7	8	25	35	71
3		1	6	11	19	13	43	
3 C		4	7	13	36	52	86	
4	4	1	0	3	7	9	11	
4 C	5	1	0	5	6	16	42	
5	6	2		2	14	26	13	33
5, 6 C	2	3		6	20	22	15	74
6	1	3		4	6	11	17	27
7	5	3	1	2	16	5	11	25
7 C	5	6	1	12	26	30	31	100

RECORDS MADE TO DETERMINE UNIFORMITY OF PLANT GROWTH.—Methods developed by the Delta Laboratory of the Bureau of Entomology were used. Detailed records were made at frequent intervals, but those records are too voluminous to be given here.

POISON APPLICATIONS.—Applications of poison were always made, when there was dew on the plants, usually between the hours of 4–7:30 A. M. Hand dusters and two row traction dusters were used in making applications.

Table 4, gives the dates of poison applications, the quantity of poison used and the labor required.

TABLE 4. POISON APPLICATIONS

Plat No.	Date Applications July	August	Sept.	Total Lbs. Poison	Total Hrs. Labor
1	28	3 11 15 21 25 31		27.72	4.7
2		13 20 25		24.	3.
3		10 15 21 25 29		36.55	5.
4		25 31	5 11	34.24	3.85
5		20 25 30	10	25.84	4.
6		20 25 30	10	23.	4.
7		13 20 25 30		25.88	3.66

REDUCTION IN SQUARE INFESTATION.—Results secured from the use

of calcium arsenate dust and the percentage of square infested, after the beginning of poisoning.

TABLE 5.

Date	Infestation Poisoned	No. Plots	Infestation Check	No. Plots	Poison Reduction
Aug. 2.....	5.5 %	1	18.8 %	1	13.3 %
Aug. 7.....	14.	1	19.3	1	5.3
Aug. 15.....	15.57	7	27.71	5	12.14
Aug. 22.....	9.24	11	34.48	7	25.24
Aug. 29.....	13.03	13	47.67	8	34.64
Sept. 6.....	21.66	8	80.14	5	58.48

The percentage of increase in bloom production of poison plots over checks is shown in table 6.

TABLE 6.

Plat No.	August 13	15	22	29	Sept. 4	8
1		49	291	508	504	
2	11		32	59	313	
3		17	78	460	643	
4			13		45	
5				61		125
6			33	43		125
7		97	88			210

YIELD.—The production of seed cotton on comparable plots is given in table 7.

TABLE 7.

Plat No.	Yield Lbs. Seed Cotton per Acre. Check	Poisoned	Increase Lbs. Seed cotton over check
1	338	541	203
3	581	726	145
4	724	1085	361
5	1019	1406	387
6	1019	1195	176
7	699	845	146

The average increase in yield was 24.45 percent or 236 pounds of seed cotton per acre.

THE IMPORTANCE OF THE FLAXSEED COUNT IN PREDICTING THE ACTUAL FLY-FREE-DATE

By C. J. DRAKE, F. A. FENTON and F. D. BUTCHER, *Ames, Iowa*

ABSTRACT

The period of emergence of either the fall or spring brood of Hessian flies, *Phytophaga destructor* Say, varies from year to year with bioclimatic conditions. On this account "fixed" or "approved" dates are unreliable and the seeding date each year should be correlated with the season and with the fall brood of flies. In Iowa, the

flaxseed count has been the only constant and reliable factor to use in predicting accurately the actual fly-free-date. One hundred or more flaxseeds were collected at each station each day (average about 1,000 per day at Monona county station) from old stubble dug up at random in heavily infested fields. These flaxseeds were then classified as parasitized, empty and viable. The viable flaxseeds were then dissected to determine the per cent of larvae, of pupae and of parasitized larvae. Hence, the flaxseed count gave the daily rate of transformation from the larva to the pupa and to the adult state, as well as the rate of approach of the fly-free-date. When this count yields very few pupae and only a small per cent of larvae in contrast to a large number of empty flaxseeds, it is proof that the actual fly-free-date is at hand and that the few remaining pupae will immediately issue as flies, lay their eggs and perish before wheat drilled at this time will come up. Thus it is possible to predict the fly-free-date so that farmers can begin drilling wheat six or seven days before the end of the egg laying period of the fall brood of flies. The records of the Iowa Observation Stations for 1922 and 1923 are given in the form of a summary.

On account of the importance of the wheat crop to man, probably no insect pest has received more attention or has ever had more said or written about it and its depredations than the Hessian fly,[1] the principal field enemy of the young-growing wheat plant. For many decades it has been a well-known fact that there was a safe date (short period) to sow winter wheat and also, at the same time, to produce a maximum yield. The solution of the problem of *predicting the fly-free-date* has been a perplexing one for years.

Seeding late to avoid Hessian fly damage was recommended by many of the earliest writers. This general recommendation was followed by the "fixed" fly-free-date method. The latter method, based largely on altitude, longitude, latitude and an average of previous safe-sowing records, proved satisfactory in "average" or "normal" years. Frequently, however, farmers who scrupulously followed these "approved" or "fixed" dates suffered heavy losses. While the theory of late planting is good, the fallacy of setting a fixed or static safe-date is evident when it is known that the period of the emergence of either the spring or the fall brood varies from year to year with climatic conditions.

In spite of seeding wheat on the proposed safe dates, the Hessian fly has been a serious pest in the Mississippi Valley during the past few years. These outbreaks brought out forcibly the fact that the "fixed" seeding dates are unreliable and that each year the seeding date should be correlated with the season and with the fall brood of the flies. As a result, several changes have been made in methods for determining the fly-free-date. Field studies carried on in Ohio by Gossard and Parks disclosed the fact that the fly-free-date varies considerably from year to

[1] *Phytophaga destructor* Say; family Cecidomyiidae; order *Diptera*.

year for a given locality. Their daily records also showed the wavering appearance of the flies and the egg-laying records of the fall brood.

Predicting the Actual Fly-Free-Date

On account of the extremely fluctuating emergence of the flies in the field and in the concentration boxes, together with the rate of egg-laying on the young wheat plants, the writers found the flax-seed[2] count to be the only constant and reliable factor to use in *predicting* the *actual* fly-free-date. This daily count determined the exact percentage of flies emerged, parasitized, as well as those in the larval and pupal stages. Moreover, when the count showed very few pupae and only a small per cent of larvae in contrast to a large number of empty flax-seeds, it was proof that the *actual* fly-free-date was at hand, and that the few flies yet to emerge would issue, lay their eggs and perish before wheat drilled at this time would come up.

Iowa Observation Station Records[3]

Monona County station, Onawa, 1922:—A total of 19,225 eggs were laid on the 100 marked wheat plants during the 25-day emergence period of the fall brood from September 10 to October 4, an average of 769 per day. From the two concentration cages 13,926 flies issued and 1,156 were caught on the migration screen. The crest of the brood occurred September 29 (Fig. 12), on which day the actual fly-free-date was announced. In 1923, conditions were radically different at this station. When the observations were started September 5, flax-seed counts showed that about 31 per cent of the puparia were viable, the rest having emerged as flies or parasites. This year, 1923, a total of 7,150 eggs were laid on the 100 plants during a 19-day period, an average of 375.7 per day; 477 flies issued in the concentration boxes and 182 were caught on the migration screen. The heaviest recorded egg deposition occurred between September 10 and 18, being interrupted by a rain and a four-day period of cool weather (Fig. 13). Seventeen and five tenths per cent of the puparia issued as parasites and 28 per cent of the holdover larvae were parasitized. The fly-free-date for this county, 1923, was announced on September 25, four days earlier than in the preceding year.

[2]The flax-seeds were taken from old wheat stubble dug up each day at random in the field. The puparia were classified as parasitized, emerged and viable. The latter were then opened to determine the per cent of larvae, pupae and unemerged parasites.

[3]For further details see Ia. Agr. Exp. Sta. Cir. 86, 1923.

Page County station, Essex, 1922:—A total of 2,897 eggs were deposited on 100 plants during a 24-day emergence period of the fall brood from September 16 to October 9, an average of 120.7 eggs per day. From the two concentration cages 1,619 flies emerged, and 1,060 were caught on the migration screen. The peak of the emergence was reached Cctober 1 and the actual fly-free-date, based on flaxseed counts, was announced October 3. Six days later the egg laying period for the fall brood was over. The fly-free-date for this county was also announced on this same date in 1923.

Mills county station, Imogene, 1923:—A total of 12,918 eggs were laid on 100 plants, during the 32-day emergence period from September 8 to October 9, an average of 403.6 per day. From the two concentration cages 2,877 flies issued and 520 were caught on the migration screen. The crest of the brood was reached September 29 (Fig. 14). The actual

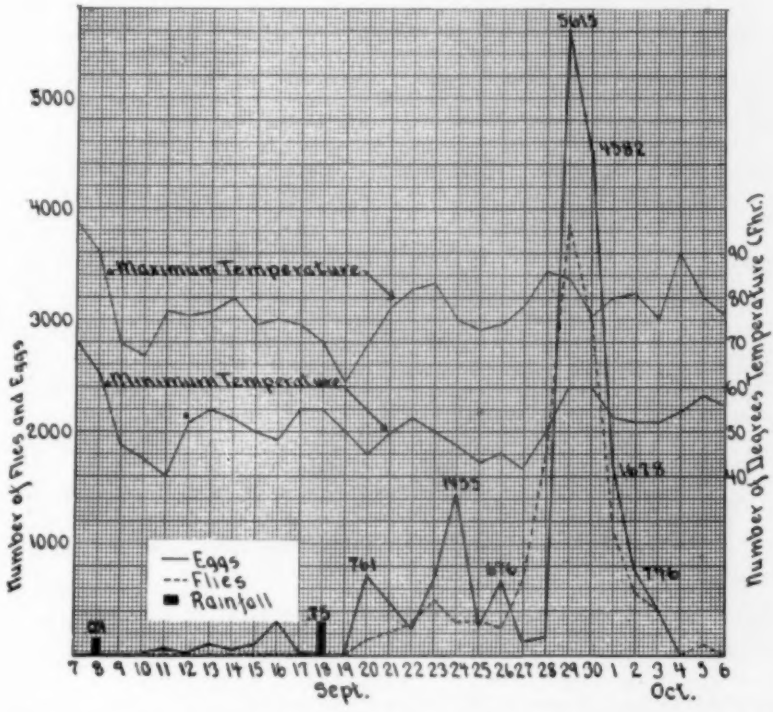

FIG. 12. Graph showing daily egg and fly records at the Monona County District Station, Onawa, 1922

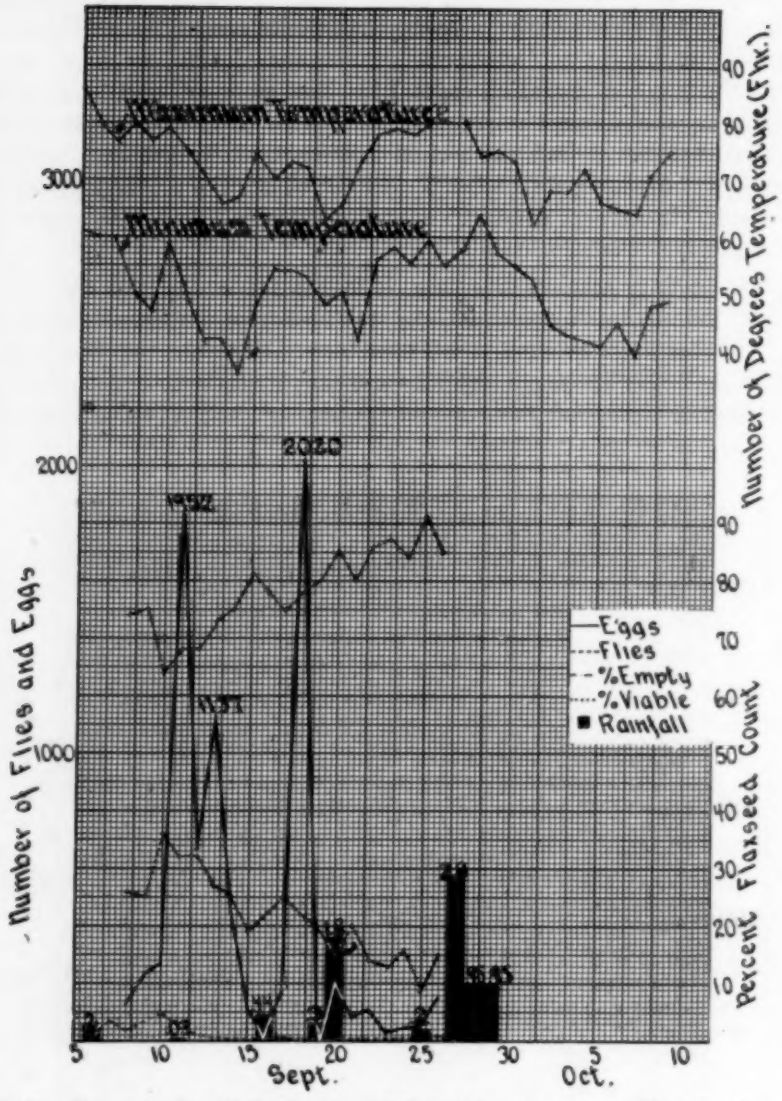

FIG. 13. Graph showing daily egg, fly and flax-seed records at the Monona County District Station, Onawa, 1923

fly-free-date was announced October 2, seven days before the fall brood had entirely disappeared.

Appanoose county station, Udell, 1923:—A total of 9,005 eggs were

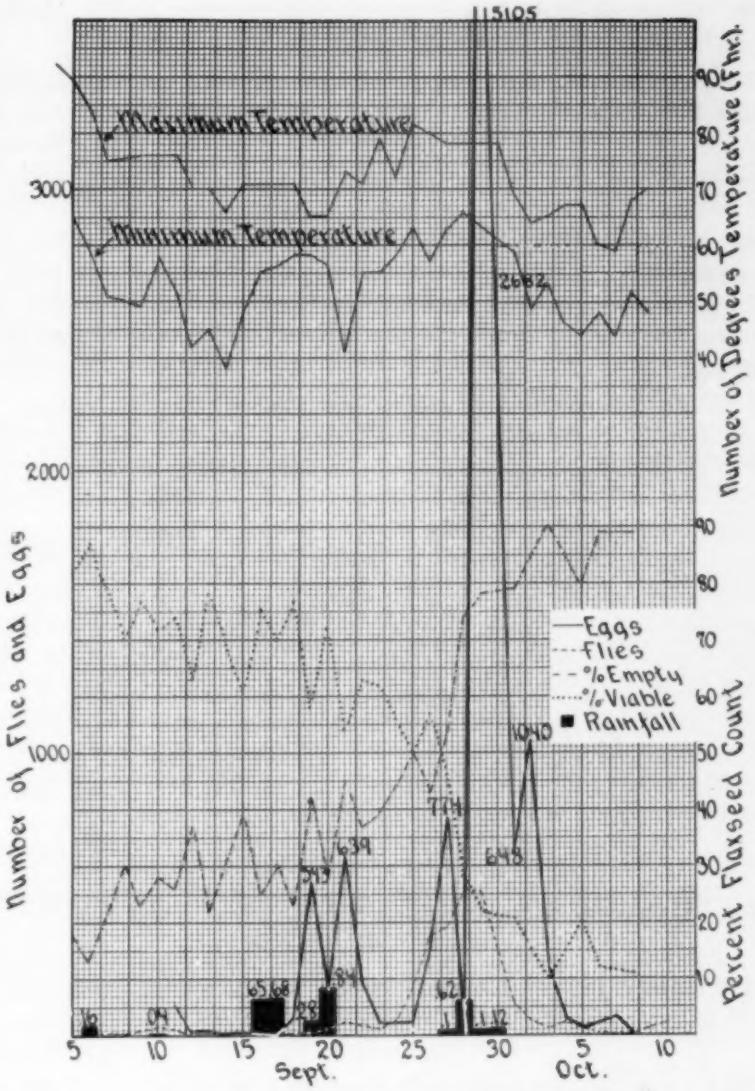

FIG. 14. Graph showing daily egg, fly and flaxseed records at the Mills County District Station, Imogene, 1923

laid on the 100 wheat plants during the 27-day emergence period from September 8 to October 4, an average of 333.5 per day. From the two concentration cages 645 flies issued and 664 were caught on the migration

screen. The peak of the brood was reached September 21 (Fig. 13), and the fly-free-date was announced October 3.

Warren county station, Spring Hill, 1922:—A total of 9,166 eggs were laid on the 100 wheat plants during a 29-day emergence period from September 8 to October 6, an average of 316 per day. From the two concentration cages 1,804 flies issued, and 524 were caught on the migration screen. The crest of the brood occurred September 23, but a second heavy egg deposition took place October 1. The fly-free-date was announced September 30, seven days before the fall emergence was over. In this county there were only 12 wheat fields drilled before the fly-free-date in 1922. Some of these were so badly infested that they were ploughed up in the spring of 1923. As a result of such excellent cooperation the Hessian fly was reduced in numbers far below the danger point for the whole county. In 1923 the station was located at Indianola. Only 193 flies emerged from the concentration cages during a 26-day period from September 8 to October 3, and 92 were caught on the migration screen, while only 16 eggs were laid on the 100 plants. The peak of the brood was reached September 25, and the actual fly-free-date was announced September 29. According to the county agent and crop reporters, the Hessian fly cost Warren County in 1922, between $125,000 and $150,000. In 1923 no injury was observed in the fields drilled on or after the actual fly-free-date, but a tax of about $750 is charged against the fly in the 12 fields drilled too early. The farmers in this county and several others were so convinced of the accuracy of the flaxseed count in predicting the actual fly-free-date that no wheat was drilled until the safe date was announced in 1923.

REARING FLIES FOR EXPERIMENTAL PURPOSES WITH BIOLOGICAL NOTES

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ABSTRACT

The house fly (*Musca domestica*), the biting stable fly (*Stomoxys calcitrans*), and the cattle horn fly (*Lyperosia irritans*) were used extensively in studies on the transmission of microorganisms by these insects. During the course of these studies simple, inexpensive and effective methods have been evolved for the rearing and handling of large numbers of flies. Special emphasis is placed on a type of breeding jar, on adult fly foods, on temperature, and on humidity. It was found that the last three have an important bearing on longevity and reproduction. To keep adult house flies alive long enough to obtain the full development of their ovaries and testes it is

necessary to feed them sugar or assimilable starch, together with a solution of proteins or products of protein hydrolysis. In regard to the food for adult *Stomoxys*, the use of defibrinated cow or horse blood warmed to a temperature of 35–37°C. proved to be satisfactory for this form. This procedure facilitates the omission of living higher animals as a source of blood for the flies. A number of minor biological and life-history observations are included in the article.

The article was written for investigators who use flies for disease, genetic, physiological or other biological researches.

I. Introduction

During the past four years the writer has reared large numbers of three species of flies for use in studying certain problems dealing with the relation of bacteria to these insects. These studies necessitated the development of simple, inexpensive and effective technical methods for rearing and handling large numbers of flies under experimental conditions and it is hoped that the present paper will give other investigators, interested in this phase of entomology, an opportunity to profit by or to elaborate upon and modify the experiences encountered.

So many biologists have reared flies for use in dealing with disease, genetic, physiological and other researches that it is difficult to distinguish between what is technically old and new. Much credit is due to such investigators as Howard, Jepson, Hewitt, Bacot, Graham-Smith, Bishopp and others, and the present paper does not in any way wish to minimize or overlook that which has been already accomplished. The methods of various investigators are scattered throughout a host of books, journals and bulletins which are not all readily accessible to any one individual. However, the writer feels that he has absorbed most of the important methods described, has modified these to meet other needs, and has introduced new links in the chain wherever this was considered advantageous.

Musca domestica L., *Stomoxys calcitrans* L., and *Lyperosia irritans* Rob.-Desv. were the three species bred and handled. Certain procedures that are generally applicable to these will be first explained. This will be followed by separate descriptions of procedures applicable only to a single species.

2. General Methods

To start new cultures wild flies are caught around stables while sitting or feeding on horses and cattle, or while resting on the walls and sides of the stalls. They are best caught by means of small, straight phials such as shown in the illustration given on Plate 10, Figure 4. The open phial is moved very slowly and steadily towards the resting or

feeding fly until approximately ½ inch from the insect's dorsal surface when a sudden, quick movement will span the remaining distance and capture the quarry. By using one phial as a storing bottle and another as a catching one, several flies may be transferred to the storing phial. This is accomplished by taking advantage of the flies' positive heliotropic reponses. The means used for transferring living insects from one phial or bottle to another is too well known to deserve further comment. If two or three dozen phials are used, aprpoximately one hundred flies may be caught during the course of an hour, provided they are plentiful. This method of catching the insects is simpler and preferable to the use of nets and traps; injury to the flies is avoided, one can nearly always instantly determine which species or sex is being caught, and with a little practice one can obtain a larger number of the desired flies in a shorter while than in any other way known. The phials may also be washed and sterilized should this be desirable.

On starting a new culture early in the spring when the adults are first appearing and the gonads are still undeveloped, it is necessary to capture both sexes and feed them about two weeks in order to produce a sufficient number of fertile eggs. Later in the season only females with swollen abdomens should be taken. These are usually fertile and ready for oviposition on a favorable medium. Indeed, very often gravid females will oviposit in the collecting bottles.

The newly captured flies may now be transferred to the breeding jar. A type of jar devised, which proved highly satisfactory, is shown on Plate 9, Figure 1. It consists of an ordinary battery jar with a wooden top which is covered with a No. 20 mesh (400 meshes to the square inch), copper wire gauze. The center of the top is perforated by a hole one inch in diameter and just large enough to insert the opening of a collecting phial. In making the hole, the one-inch diameter auger is replaced by a three-fourth-inch diameter one when three-quarters of the distance has been bored. This forms a narrow shelf upon which the collecting phial may rest. The reverse side of the top is shown on Plate 9, Figure 2. It will be seen that the entire top is cut from one piece of wood. The grooves for fitting the top to the battery jar are also shown at the junction of the central support and the rim of the top. Since the diameter of the tops and jars vary slightly it is difficult to obtain a close fit. This can be corrected by making a paper collar as shown in Figure 1. About one-fourth to one-third of a jar is filled with the larval medium (horse manure, fermenting straw, or cow dung) packed loosely with a wooden stick and moistened slightly with water.

The paper collar and top are now fitted and a cork inserted into the opening.

The captured wild flies are now introduced. This is effected by taking the corks out of the breeding jar and phials and by inserting the latter into the opening of the breeding jar top. By darkening or by shaking the phials a little, the transfers can be made quickly. Except when wild flies are caught early in the spring, the adults need not be fed. The females readily lay their eggs on the medium and development soon follows. During the entire life cycle the temperature and humidity of the rearing room must be watched. The temperature should not fall much below 25°C., and 30°C. seems to be very favorable. The atmosphere must not become dry. In the summer it is possible to ventilate extensively and the outside air (in New Jersey) maintains the proper humidity within, but when cold weather arrives and it is necessary to resort to artificial heat, water should be evaporated constantly, otherwise the breeding medium will rapidly dry out and become hard, especially in the upper layers. The medium must further be moistened from above every few days, but great care should be taken not to add too much water so as to avoid drowning the maggots in the lower part of the jar. With a little practice the necessary absorbing capacity of the medium for water can be readily determined.

The first generation of reared adults will usually emerge during a period of several days. This is very convenient for the experimenter, because if the entire brood issued on one day it would be very difficult to utilize all the material to the best advantage. The adults are extracted by the method shown on Plate I, Figure 3. The breeding jar is darkened with a black cotton bag having a draw string at the open end so that it may be closed tightly around the edges of the breeding top hole. The cork is now taken out of the breeding jar top and a wide-mouthed, six-ounce bottle is quickly placed over the opening. This type of bottle is large enough to hold many flies and is also flanged, so that the insects do not easily slide back into the jar when once extracted. By substituting empty bottles every little while, by shaking the whole outfit, by gently tapping on the top, and by permitting either sunlight or artificial light to shine from above, all the flies may be extracted in a short while. The three species used are positively heliotrophic when they first emerge and are hungry, but notwithstanding this fact, they vary somewhat in the rapidity of their responses to light, for instance, *Lyperosia* and *Stomoxys* react very quickly, on the other hand, the house fly responds more slowly and will often become negatively heliotrophic after its preliminary

positive response. To keep them from wandering back into the darkened jar after emerging into the light, it is necessary to transfer the emerged individuals into stock bottles as soon as this can be accomplished conveniently.

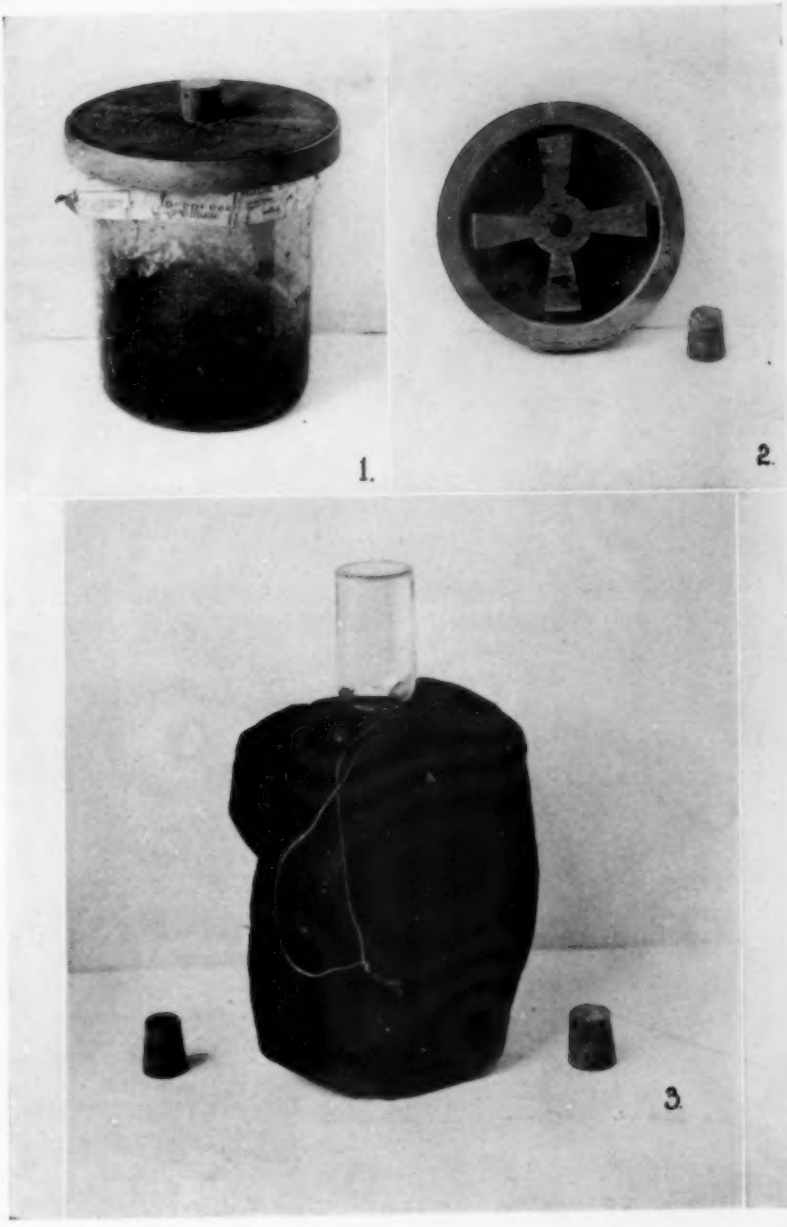
After a sufficient number of flies have been taken out, they may be studied and used for certain experiments. This is best done by etherizing[1] the insects. Care must be taken not to bring the liquid ether in direct contact with the flies, otherwise, they will not recover. The stock bottle is held towards the light for a moment, in order to drive the flies to the far end, it is then opened and a sufficient amount of ether dropped on the cork. The flies soon become etherized and may be kept in a state of light anesthesia for from ten to fifteen minutes. During this time they may be counted, identified as to species and sex, or studied further. After these procedures, the mass of flies may be used in whole or in part for experiments, or they may be used to start a fresh brood.

If the insects are to be used for breeding purposes, approximately an even number of both sexes are transferred to a fresh breeding jar previously sterilized[2] and prepared with the medium. They are fed for the first time after complete recovery from the anesthesia, but the writer has found that flies will not take much food until the day following this treatment. In order to obtain a large crop the succeeding generation, feeding must be practiced for about two weeks or until the majority of the females are seen to be ovipositing. In general, it has been the practice at this laboratory to cease feeding the adults when newly hatched maggots are seen to be working within the medium. After the feeding is stopped the adults soon die or they may be extracted and killed.

The best types of food for the adult flies will be described later under the sections dealing with the individual species. Certain conditions of the food and method of feeding are, however, applicable to the three species. All food is prepared under sterile conditions and is stored on ice in bottles or test tubes until used. With the exception of lump sucrose, employed as one of the essentials for house flies, all foods are in a liquid or semi-liquid state, and are warmed to about 37°C. or 38°C. before using. By means of sterile pipettes drops of the food are deposited over the entire surface of the wire gauze top of the breeding jar. Three large drops deposited in each spot are usually sufficient to permit part of

[1]Chloroform kills many insects even when lightly administered.

[2]Between broods the jars, tops and corks must be cleaned, scrubbed and sterilized. The sterilization is practiced for the reason that otherwise bacteria pathogenic to flies may be transferred from one brood to another.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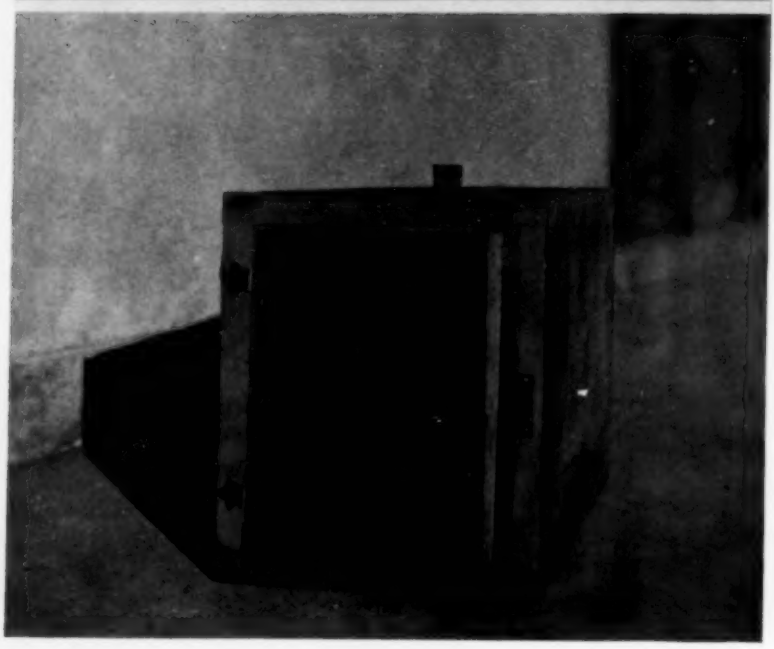

the liquid to hang down on the reverse side of the top. This, naturally, is a great aid to the flies in obtaining a sufficient amount of food. The food is tendered for about 15 to 20 minutes. During this time all flies requiring food will have fed. The remaining fluid is then absorbed with absorbent paper towels and the tops (left in place) are scrubbed with hot water by means of a stiff hand brush.

If a new brood of adults is to be used for study instead of breeding, individuals may be isolated or a certain number of one sex or of both sexes segregated. For this purpose the wide-mouthed, six-ounce bottles shown on Plate II, Figure 4 are employed and a breeding medium may be first introduced should this be desirable. The transfers from the breeding jar are effected as previously described and the desired flies placed in the experimental bottles while under anesthesia. Cotton gauze tops held in place by rubber bands keep the flies from escaping. A bell or battery jar, as shown in the figure, may also be placed over the bottles to keep wild stray flies from contaminating the tops.

The flies in the experimental bottles are fed by permitting the liquid or semi-liquid food to drop upon the cotton gauze tops from pipettes. Three drops from an ordinary pipette are usually sufficient for from six to twelve flies. The third drop usually falls through, which is a good thing, since two or three individuals in a bottle always seem to prefer to take their food at the bottom instead of at the gauze top. Feeding, engorgement with the consequent tremendous swelling of the abdomen, and the passage of feces later are all indications that the food offered has been accepted.

As a matter of routine, the flies subjected to experimentation were transferred to fresh sterile bottles three times a week and fresh tops replaced the old ones. However, if a particular bottle became unduly soiled the flies were transferred to a fresh bottle as soon as the condition was noticed. It is important to watch the bottles, because flies become soiled easily with liquid or semi-liquid food, especially when old and weak. When in this condition they frequently stick to the glass where they die of hunger or exhaustion. When found in this predicament and still alive, they can be saved by removing them with a pair of blunt forceps and washing them off under a gentle stream of lukewarm water from the tap. In most cases flies so treated will recover and appear normal the next day.

Experience in using both the experimental bottles and the breeding jars has shown that it is necessary to feed adult flies daily without exception. No advantage is gained by feeding *M. domestica* or *Stomoxys*

more than once a day, but *Lyperosia irritans* must be provided with fresh food twice daily, in the morning and in the evening. Unless this rule is adhered to rigidly the worker will obtain an unduly high starvation mortality which will seriously interfere with his experiments.

Two species of flies, namely, *M. domestica* and *Stomoxys calcitrans*, have been reared by the writer from approximately the middle of April until the middle of December. The artificial conditions (artificial heat, food, etc.) seem to manifest their influence at this time, however, for it has so far been impossible to rear these flies during the remaining four months of the year.

The cage shown on Plate 10, Figure 5, was devised for use in feeding blood-sucking flies on small laboratory animals such as rabbits and guinea pigs. The wire gauze is the same mesh as that used for the breeding jar tops and will not permit the passage of a small fly like *Lyperosia irritans*. The cork closing the hole for introducing and extracting the flies is shown on the top of the cage. When flies are extrated the cage is enveloped in a black cotton bag. The hair of most laboratory animals is very long and must be clipped in places so that the flies can feed. It is also often desirable to shave the skin over small areas. Due to the discomfort experienced by having the skin punctured by many flies, it is advisable not to expose the animals, at any one time, for more than a few minutes.

3. Special Features

Besides giving a few special technical hints in this section, the writer has also found it necessary to add a number of biological observations. This is not meant to include a detailed account of the life history of flies as this has already been accomplished by others. One cannot, however, work with a group of animals for any great length of time without noticing a few things that appear new and have been overlooked.

M. domestica L.

House flies have been reared by the writer from the middle of April until the middle of December. At this time the last generation of adult flies oviposited, but the progeny died either in the larval or in the pupal stage. These cultures were comprised of bred flies in the fifth and sixth generation. Whether the mortality of the cultures was due to the cumulative effect of the artificial conditions under which they were reared or not, it is at present difficult to conclude. It does not, however, seem to be simply a freak occurrence appearing only a single time. Three cultures in 1924 abruptly concluded their development in the manner described.

Fermenting bran and hay, horse manure, and other materials were used for a larval medium, but the horse manure was selected as the best and most practical. This must always be obtained in a perfectly fresh condition, so as to exlude the possibility of ovipositions by wild flies. Unless a culture is started with wild adults early in the spring, the probability is that the preoviposition period and fertilization have been completed and feeding of the wild flies may be omittted. The females soon seek holes or crevices between particles of manure and crawl into these if possible. The ovipositor is then extended and periodically undergoes contractive movements which expel the eggs. The time of the hatching of the larvae varies with the temperature. At 30°C. or 35°C., the larvae will hatch within twelve hours after oviposition; if below 30°C., it may take twenty-four hours, and if below 20°C., hatching may be postponed for a few days. According to Hewitt (1) "there are three larval stages or instars, the larva moulting twice during the course of its development." This author gives the following most probable minimum time of duration for each of the stages from egg to adult: egg stage, 8 hours; 1st instar, 1 day; 2nd instar, 1 day; 3d instar, 3 days; pupal stage, 3 days; making the total minimum period from egg to adult 8 days, 8 hours. Under certain experimental conditions Hewitt was able to obtain as short a record as 8 days, 4 hours, but he states that this is probably exceptional and that "it is unlikely that in the hottest weather development would be accomplished in less than nine days. These minimum periods are the result of a large series of experiments in which it was a more common occurrence to have a batch of larvae developing in ten, fifteen or twenty days." The writer was able to verify Hewitt's observations and obtain 13 to 19 days as the time required from egg to adult under temperature conditions varying from 20°C.–35°C.

The total durations given above, it must be explained, are those from egg to adult and not from adult to adult. The preoviposition period, or the period between emergence from the pupal case and the full development of the adult male and female reproductive organs followed by fertilization, is an important phase in the life of these insects. This phase in the life history can only be accurately determined by breeding flies for a number of generations.

In 1923 the writer (2) showed that certain types of food are important longevity and reproductive factors for adult flies. To keep adult house flies alive long enough to obtain the full development of their ovaries and testes it is necessary to feed them sugar or assimilable

starch, together with a solution of proteins or products of protein hydrolysis. These materials may be given in the form of lump sucrose dropped into the breeding jar or semi-liquid starch paste dropped on the cover. This must be supplemented with nutrient bouillon, blood serum or egg white. Milk alone is also an efficient food on account of the fact that it contains the two factors mentioned in the form of lactose and casein.

On the foods mentioned the longevity of the adult *M. domestica* varies from 2 to 57 days, with an arithmetical mean of 20 + days. During this time the ovaries and testes develop and eggs are deposited in from 11 to 24 days with an arithmetical mean of 15 days.

The sex ratios of all the cultures, whether from first generation flies obtained from wild females or from inbred material, showed certain slight variations, but in general the sexes are equal numerically. An effect on the sex ratio, that could be directly and safely attributed to climatic conditions or to a special type of food was not obtained.

Stomoxys calcitrans L.

The biting stable flies have been reared by the writer from April 22 to December 7. After this time the cultures automatically "died out" as with the house flies.

Fermenting oat straw alone, horse manure alone, and a mixture of the two were extensively used for a larval medium. As a matter of routine, pure horse manure was finally adopted as the best and most practical medium. The cultures are prepared in the manner described for *M. domestica*.

The life history of *Stomoxys calcitrans* has been very fully and accurately described by Newstead (3) in 1906, and by Bishopp (4, 5) in 1913 and 1920. It is very similar to that of the house fly. If wild gravid females are put in the breeding jars, they soon lay their eggs which hatch in from 1 to 3 days. According to Bishopp larval development takes 11 to 30 days or more, and the metamorphosis within the pupal case 6 to 20 days or longer depending on the temperature. Bishopp obtained 18 days as the minimum time and 53 or more days as the maximum time required for development from egg to adult.

The writer has noticed a somewhat greater effect of temperature on the rapidity of development in *Stomoxys* than in house flies. During very hot weather the cycle from egg to adult may be spanned in as short a time as 14 days, whereas cool spring or autumn days may prolong the period to 43 or more days.

To obtain the development of the ovaries and testes of bred *Stomoxys*,

in other words, to cover the time required for the preoviposition period, the insects were first fed directly on horses and cattle. This was effected by placing a number of newly emerged male and female flies in a wide-mouthed six-ounce bottle covered with cheesecloth and pressing the covered end firmly against the back or side of the host. The flies soon insert their mouth parts through the cheesecloth top and feed. This method of feeding biting flies is tedious, however, as the bottles must be held to the animals for at least a half hour to insure the engorgement of all the flies. When many flies are to be fed, it is almost impossible to do anything else during the course of the day. The horse or cow are partly restrained in stanchions during the operation but, nevertheless, often violently resent being punctured in one place by a dozen or more flies and this, of course, does not add to the simplicity of the procedure. Small fly cages attached to horses or cattle are of no value, for these are rubbed off as soon as the irritation caused by the feeding insects begins.

The use of small laboratory animals, by means of the cage previously described, next suggested itself. This method proved somewhat better, provided one is fortunate enough to acquire a phlegmatic guinea pig or rabbit. Most of these animals, however, become extremely nervous and active when attacked by flies and will usually not permit them to remain upon them long enough for complete engorgement.

It was found that reared *Stomoxys* engorge readily on defibrinated, whole horse or cow blood when the latter is warmed to a temperature of 35°C.–37°C. The blood is obtained under sterile conditions from the jugular vein of the animals, is defibrinated, and stored on ice until needed. A large enough amount to supply the needs for about two weeks is obtained at one time. On feeding, the serum and cellular elements are mixed with a pipette, the mixture warmed and dropped on the breeding jar or bottle covers.

When reared *Stomoxys*, in mixed sex cultures, are fed defibrinated blood they will oviposit from three to seven times and lay many eggs. These eggs hatch, develop and produce another generation of flies. Up to date five generations of *Stomoxys clacitrans* have been reared in this manner.

The longevity of reared adult *Stomoxys* thus fed varies from 3 to 46 days, with an arithmetical mean of 20 + days. The preoviposition period varies from 9 to 13 days, with an arithmetical mean of 10 + days.

The sexes of bred *Stomoxys* are approximately equal, with a slight preponderance of males. No effect on the sex ratio was noticed that

could be certainly and safely attributed to climatic condition or to food.

Lyperosia irritans ROB.-DESV.

The horn fly confines its attentions exclusively to cattle on which it remains day and night with the exception that at intervals females with mature eggs dart down to fresh deposited cow dung for the purpose of oviposition. Having accomplished this function, they return to the cow where they either feed again or rest.

When wild, gravid females are placed in breeding jars with fresh cow dung and fed defibrinated cow blood, some will remain alive for as long as 25 days, but cease laying eggs in from 3 to 5 days. The eggs hatch in 2 to 3 days, depending upon the temperature, and larval development follows. The minimum time required for a culture to complete its cycle from egg to adult was 11 days during an exceedingly hot wave in July. The maximum periods consumed during cooler weather were 20 days in May and 22 days in October.

The first generation of reared *Lyperosia*, artificially fed, live from 1 to 24 days, but lay no eggs. For this reason it has not been possible to rear this fly beyond the first generation of adults.

In a previous publication (2) the matter of the resistance of *Lyperosia* to propagation under experimental conditions is discussed, after many attempts were made to induce the development of the reproductive organs of the first generation of reared males and females. It is difficult to conclude whether the food, the treatment, or both were responsible for this behavior.

In concluding the subject of *Lyperosia irritans* it might be well to state that the sexes of the first generation of reared adults are numerically equal.

SUMMARY

Simple, inexpensive and effective methods of rearing and handling large numbers of flies have been described in this article. A number of observations on the biology of *Musca domestica*, *Stomoxys calcitrans* and *Lyperosia irritans* are likewise included.

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PARASITISM OF SCALES—SAN JOSE AND OYSTER SHELL

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ABSTRACT

The San Jose scale, *Aspidiotus perniciosus* Comst., and occasionally the Oyster Shell scale, *Lepidosaphes ulmi* L., are serious pests in many fruit growing districts. Parasites often play an important role in reducing these scales.

In order to determine what species of parasites were present, samples of infested twigs were collected from several regions and the following species of parasites were bred: From San Jose scale—*Prospaltella perniciosi* Tow., *Aphelinus fuscipennis* How., *Aphelinus mytilaspidis* LeB., *Signiphora pulchra* Gir., *Perissopterus* sp., and *Ablerus clisiocampae* Ashm.; from Oyster Shell scale—*Aphelinus mytilaspidis* LeB.

During the last few years the San Jose scale (*Aspidiotus perniciosus* Comst.) has attracted considerable attention in many important fruit growing districts. It has multiplied in such enormous numbers as to cause alarm among orchardists. In some of the more heavily infested districts many hundreds of trees were killed or badly injured before the seriousness of the situation was fully realized and effective spraying measures brought into play.

In connection with the study of the scale problem it was thought desirable to ascertain the parasites present. With this in view ten lots of twigs infested with the San Jose scale and one lot infested with the oyster-shell scale (*Lepidosaphes ulmi* Linn.) were received at the Sligo, Md., laboratory in late August and early September of 1922. The twigs were securely wrapped in waxed paper and upon receipt were at once placed in glass test tubes stopped with cotton. The parasites soon commenced to emerge, the total period of emergence extending for about three weeks.

An examination of the parasites showed the presence of six species[1] from the San Jose scale and one from the oyster-shell scale. One of the species, *Aphelinus mytilaspidis* LeB., was common to both of the scales.

In table I, will be found a list of all the parasites that emerged and the number of each.

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[1]Determined by Mr. A. B. Gahan of the U. S. Bureau of Entomology, Wash., D. C.

TABLE 1. PARASITES OF THE SAN JOSE SCALE

Place collected and collector	Host	Parasites: Aphelinus mytilaspidis LeB.	Aphelinus fuscipennis How.	Prospaltella perniciosi Tow.	Ablerus clisiocampae Ashm.	Signiphora pulchra Gir.	Perissopterus sp.
Fort Valley, Ga.							
O. I. Snapp	Peach	0	0	0	0	0	0
Aurora, Ill.							
C. C. Compton	Apple	0	0	39	0	0	2
Unknown							
Unknown	Apple	0	0	0	0	0	0
San Pierre, Ind.							
J. J. Davis	Apple	0	0	1	0	0	0
Lafayette, Ind.							
J. J. Davis	Apple	18	17	512	1	8	0
Bicknell, Ind. (1)							
J. J. Davis	Apple	0	4	85	0	0	1
Bicknell, Ind. (2)							
J. J. Culver	Apple	0	0	24	0	0	0
Washington, Ind.							
J. J. Davis	Apple	0	0	14	0	0	0
Bentonville, Ark.							
A. J. Ackerman	Apple	0	0	471	0	0	0
Geneva, N. Y.							
Geneva Exp. Sta.	Apple	0	2	50	0	0	0
Total.....		18	23	1196	1	8	3
PARASITES OF THE OYSTER SHELL SCALE							
Aurora, Ill.							
C. C. Compton	Apple	99	0	0	0	0	0

An examination of Table 1 will show that of the parasites emerging from the San Jose scale only one species, *Prospaltella perniciosi* Tow., was present in any appreciable number or in a majority of the localities from which twigs were received. In the case of the oyster shell scale only one species, *Aphelinus mytilaspidis* LeB., emerged.

In order to determine the degree or amount of parasitism it was necessary to make a count of the scales on the twigs and in this count all male and very immature female scales were omitted. No account was taken of the probability that a number of parasites died within the host.

In Table 2 will be found the number and length of the twigs, the number of scales, the number of parasites and the per cent of parasitism for each locality from which twigs were received.

TABLE 2. SAN JOSE SCALE—PARASITISM

Place collected	Emerged at Sligo, Md.	Number of twigs	Ave. length of twigs in inches	Number of scales	Number of parasites	Per cent of parasitism
Fort Valley, Ga.	Sept. 1922	11	4.60	7446	0	0.00
Aurora, Ill.	Sept. 1922	5	6.05	3217	41	1.27
Unknown	Sept. 1922	6	6.62	12028	0	0.00
San Pierre, Ind.	Nov. 1922	1	6.50	1456	1	0.07
Lafayette, Ind.	Sept. 1922	5	6.40	9249	556	6.01
Bicknell, Ind. (1)	Sept. 1922	22	4.81	15790	90	0.57
Bicknell, Ind. (2)	Sept. 1922	11	5.41	10436	24	0.23
Washington, Ind.	Sept. 1922	5	6.33	4614	14	0.30
Bentonville, Ark.	Sept. 1922	19	4.35	25108	471	1.88
Geneva, N. Y.	Sept. 1922	12	6.07	3077	52	1.69
	OYSTER SHELL SCALE—PARASITISM					
Aurora, Ill.	Sept. 1922	37	2.87	4591	99	2.16

An examination of Table 2 will show the per cent of parasitism as based on these samples to vary from 0.00 for the scales from Fort Valley, Ga., and an unknown locality to 6 01 for the scales from Lafayette, Ind

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FURTHER STUDIES OF DERRIS AS AN INSECTICIDE

By E. R. DE ONG and L. T. W. WHITE, *University of California.*

Extracts of Derris have been commonly reported as a valuable insecticide, the species when mentioned usually being *D. elliptica* (common name "Tuba"), the "derris" of commerce. There are forty or more species of this genus, at least twelve of which are found in the Philippine Islands. Insecticidal tests have been made with the following species by Mr. H. E. Woodworth, formerly of the College of Agriculture, University of the Philippines, Los Banos, to whom I am indebted for the following data, on species abundant in the Phillippine Islands.

SCIENTIFIC NAME	PARTS USED	DILUTION OF SOLUTION	REMARKS
Derris elliptica	stem	20%	negative
	young shoot	20%	negative
	root	20%	positive
Derris philippinensis	leaves	20%	negative
	stem	1%	positive
	stem (boiled)	20%	negative
	roots	20%	positive

Derris sp.	leaves	20%	negative
	stem	20%	positive
	flowers	10%	negative
	leaves (boiled)	20%	negative

Derris polyantha (common name "Tugle," "Malagogon-dapo") is reported by Foxworthy and Elmer in "The Flora of Makúng and its Vicinity" to contain a fish poison in its bark.

Many species of Derris in the Philippines are rank-growing vines, found in such abundance on the mountain sides that they would probably furnish a continuous supply of the raw material at a medium cost of harvesting.

The following experiments in extraction and insecticidal tests were made with the ground root of *Derris* sp. diluted with calcium carbonate and with commercial liquid and dust preparations. Four extracts were prepared from dried roots of *Derris* sp. (probably *elliptica*) using as solvents, petroleum ether, ether, alcohol and water. The ether extracts were of a yellowish brown structure, brittle at room temperature and soluble in some of the alcohols. The alcoholic extract was of a gummy nature and the water extract flaky. Pyridine was found to be the most satisfactory solvent for all the extracts except the alcoholic, which was soluble in both ethyl and methyl alcohol. From this it would seem that an alcoholic extract dissolved in wood alcohol would be an economical commercial preparation, or an ether extract dissolved in pyridine. Variations from these results might be found with different species of Derris.

Tests of the susceptibility of the guinea-pig to Derris extracts were made by sub-cutaneous, abdominal injections with the following results:

(a) One-fourth cc. of a solution made by dissolving .002 gm. pure petroleum-ether extract dissolved in one-half cc. of pyridine,—no pathological symptoms.

(b) One-fourth cc. of .103 gm. ether extract dissolved in one-half cc. of pyridine,—symptoms: rapid irregular heart action, loss of appetite and weight for three days followed by a rapid return to normality.

This indicates a very slight susceptibility to the action of Derris, since even the smaller amount was much in excess of that which would be absorbed by light dustings.

The commercial extract of sixteen per cent concentration diluted 1 to 500 gave a 13% control on *Aphis nerii* Fons., and a 50% control on the green peach aphid (*Rhopalosiphum persicae* Sulzer). Dilutions of 1 to 300 gave a maximum control of 68% on the latter species of aphid and 25% on the red spider (*Tetranychus telarius* Linn.). Dilu-

tions of the same concentrate at 1 to 500 added to mosquito infested water killed 65% of the larvae but had no effect on the pupae. The powdered derris root (undiluted) sprinkled on the surface of the water killed 90 per cent of the larvae in two to four hours. The same powder when dusted on aphids gave a 100% efficiency in eight hours and a 98% control of the larvae of *Euphydryas chalcedona* when dusted on the leaves upon which they were feeding. From these experiments it is judged that the active principle "derris" is both a stomach and a "respiratory" or tracheal poison. The reaction on the caterpillars must have resulted from ingestion of the powder, since fumigating tests with the material gave negative results, while the fumigating action of the commercial derris extract was close to that of the toxicity curve for spraying.. A check test on pyridine as a fumigant gave an efficiency of three and eight-tenths per cent.

Tests on Animal Parasites

Powdered derris root diluted to a twenty per cent concentration with calcium carbonate, as well as the commercial derris dusts, gave perfect control on the chicken lice (*Menopon biseriatum* Prag. and *Gonicotis gigas* Tasch.) and the Giropid lice (*Gyropus ovalis* Nitzsch and *Gliricola porcelli Linn.*) on the guinea-pig. The control of lice on large numbers of guinea-pigs is often a perplexing problem, especially in research work where perfect normality is desired for all experimental animals. Lice are especially difficult to control on young pigs and brood sows, the former often showing a high mortality. Powdered derris at twenty per cent dilution has given good satisfaction to the veterinarians at the University of California for this type of work, the powdered derris being applied to the birds by the pinch method of dusting on the infested areas. On the pigs, the powder was rubbed into the fur over the entire body or in treating pregnant sows the dust was applied behind the ears and on the back.

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Scientific Notes

A Pecan Case-bearer. During the past winter considerable numbers of various varieties of pecans have been introduced into widely separated parts of California. With the advent of spring and the leafing out of the trees it has been found that those trees that were introduced from Monticello, Florida were quite heavily infested with a leaf case-bearer, which seems to be *Acrobasis nebulella* Riley. The County Horticultural Commissioners are taking steps to eradicate the pest before it becomes established, as some fear is felt that it might attack English walnuts, of which there are large plantings. Adults were noted to be emerging during the second week of June.

CLIFFORD T. DODDS

An Infestation of *Autographa biloba* Steph. on Lettuce. Early in June an outbreak of caterpillars causing extensive defoliation of lettuce in a cold frame was noted at A & M College, Mississippi. Both the caterpillars and cocoons closely resembled those of *Autographa brassicae*, but since this species though always abundant in this section on cabbage and closely related cruciferous crops, rarely if ever becomes a pest on lettuce, it was suspected that another species was involved. Specimens of larvae and cocoons were collected and reared, the adult being determined by Mr. F. H. Benjamin of Decatur, Illinois as *Autographa biloba* Steph.

The damage by this species to the lettuce in the cold frame was complete, the defoliation approaching one hundred per cent. Lettuce in the garden outside the frame, less than one hundred feet distant from it, remained untouched. No other infestation has been seen in the locality, and although all the pupae in the insectary have emerged there has been up to the time of writing (July 5th) no recurrence of infestation on the location of the original infestation.

Twenty specimens were taken to the insectary. Twelve of these emerged, and six succumbed to a malady having the characteristic appearance of a polyhedral disease. One of the six was examined and found to contain great numbers of the polyhedral bodies typical of this type of disease. No parasites were reared.

H. W. ALLEN, *Mississippi Agricultural Experiment Station*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1924

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication, at $3.00 per page for all matter in excess of six printed pages; in the case of other matter, the maximum of 2,500 words is still operative. Photo-engravings may be obtained by authors at cost.

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The West Coast entomologists are to be congratulated upon the first issue of "The Pan-Pacific Entomologist" just at hand. It is published quarterly by the Pacific Coast Entomological Society in cooperation with the California Academy of Sciences. It is primarily systematic and biological and rightly gives most attention to West Coast insects. There is a large field for this new journal and a corresponding opportunity for service. All economic entomologists are interested in this venture, not only on general principles but on account of the fact that all entomology is economic in its ultimate analysis. Any effort which assists in clearing up the unkown in relation to insect life, and there is still much of this, aids the more obvious economic investigations. Therefore, we welcome a new ally.

Factors affecting the distribution of insects have a very direct economic bearing. It is well known that the cotton moth and the large *Erebus odora* are found occasionally many miles north of their normal habitat—the swarms of fresh individuals of the former being most noteworthy. Some years ago the late Dr. J. B. Smith demonstrated the occurrence of salt marsh mosquitoes 40 miles from any known breeding places. The recovery of small gipsy moth larvae after drifting across Cape Cod Bay, some 20 miles, is another well known case. The widespread occurrence of insects with limited powers of flight, this latter being predicated upon frail bodies, such as those of gall midges and aphids, suggests that the lower air currents may play an important part

in carrying them. The extensive experiments with small balloons of a low buoyancy conducted by the New York State Conservation Commission in connection with the gipsy moth work, have demonstrated that long drifts, several hundred miles, are possible within 10 to 24 hours and that upward currents over heated areas may easily carry objects capable of floating in the air to heights of several thousand feet. The recovery of plant spores at 10,000 feet in the air is significant and the finding of grasshoppers at 1,000 feet above the surface and of mosquitoes at considerable elevations all tend to show that we know too little of insect movements, probably largely drifting, in the lower strata of the air. If man, the latest mammal to invade the air, can support himself in the ether for hours with a relatively crude glider, is it not reasonable to suppose that many insects, reared for aerial existence through countless generations, could do equally well and drift on the wings of the wind with slight muscular exertion. The rather common occurrence of many insects on high mountains, on glaciers and along the shores of bodies of water, all suggest that they may have been carried by winds and dropped by descending air currents likely to be found under such conditions. Air planes are being used for the distribution of poison. Could they not be employed occasionally for securing data on the vertical distribution of insects in the lower air strata? The swarms of aphids in late summer and early fall suggest air distribution. The cotton moth invites the attention of the aviator-entomologist.

Obituary

REGINALD CHARLES TREHERNE

Reginald Charles Treherne was born at Aldershott, England, on March 24, 1886. He died June 7, 1924, at Ottawa, Canada, from acute peritonitis. He was graduated from the Ontario Agricultural College and received the degree of Bachelor of Science in Agriculture from the University of Toronto in 1909. During the summer of 1908 he was employed in entomological investigations by the Louisiana State College and during the summer of 1909 was engaged in nursery inspection work in the Province of Ontario. In the same year he was appointed a field officer in the Dominion Entomological Service and for two years was engaged in investigations in the Provinces of New Brunswick and Ontario. In 1911 he was transferred to British Columbia, where he remained until 1922. He was promoted in 1915 to the position of Entomologist in Charge of Insect Investigation of British Columbia.

In 1919, when the Provincial and Federal entomological activities were coordinated, Mr. Treherne was given the general direction of the work. In 1921–1922, in addition to his duties as Provincial Entomologist, he lectured in Entomology in the University of British Columbia. His entomological investigations in British Columbia related to the bionomics and control of such important pests as the cabbage root maggot, the onion maggot, the strawberry root weevil, the pear thrips, the codling moth, the pear twig borer, and several species of grasshoppers destructive to crops grown on ranch lands. In all of this work Mr. Treherne attained leadership and a large part of the development of the Federal and Provincial entomological work in British Columbia is accredited to the organization perfected by him.

In 1922 Mr. Treherne was transferred to Ottawa and advanced to the position of Chief of the Division of Field Crops and Garden Insects of the Dominion of Canada. One of the first things he undertook in his new position was to inaugurate the Insect Pest Survey and the Insect Pest Record, both of which have been of real service to entomological workers. In spite of his pressing duties in directing economic entomological work, Mr. Treherne found time to devote considerable attention to the Thysanoptera, of which he was fast becoming a leading authority. He also took a keen interest in boys and only a few months before his death had become identified with a new movement in Canada known as the Rover Scout Movement.

Mr. Treherne was a member and an active worker in the following important scientific societies:

American Association of Economic Entomologists
Entomological Society of America
Ecological Society of America
Entomological Society of Ontario
Association of Economic Biology (England)
Fellow of the Entomological Society of London (England)

During his residence in British Columbia he was an active worker of the Entomological Society of British Columbia and its success during his residence in the Province was due largely to his efforts.

His earnest desire for economic entomology to develop on that broad and constructive plane so necessary for the rendering of the maximum service and usefulness was well illustrated by his leading part in the inauguration of and the participation in meetings of Entomologists engaged in similar entomological problems. This was particularly true in regard to entomological workers interested in the European corn

borer. His fine generosity and vision of professional service were largely instrumental in determining the practice of free interchange of plans of investigations and unpublished information on the European corn borer problem which has characterized the work in Canada and the United States from the first. The loss of his fellowship, experience, and resourcefulness is incalculable. In his untimely death Entomology has suffered a real loss, and his associates and co-workers in Canada and the United States will feel intimately the loss of his fine personality.

GEO. A. DEAN
F. C. CRAIGHEAD
J. E. GRAF

Current Notes

Mr. Alfred Lutken, Picayune, Miss., has resigned from the Bureau of Entomology.

Mr. A. L. Strand, assistant professor of entomological extension at Pennsylvania State College resigned to take effect April 15.

Mr. P. D. Sanders, M.S., University of Maryland, 1924, has been appointed Assistant Entomologist at the University of Maryland.

Mr. Henry Stabe, a graduate student in zoology and entomology at Iowa State College, has accepted an instructorship in entomology at Louisiana State University.

Mr. Geo. S. Lanpford, M.S., University of Maryland, 1924, has been appointed Deputy State Entomologist of Colorado, and assumed his new duties June 1st.

Professor George A. Dean and W. R. Walton visited Brooklyn, N. Y., May 22, to inspect the clean-up work being done there at the European corn borer infestation

President A. F. Burgess has just taken a month's trip to the Pacific coast, visiting a number of entomological departments and field stations on the way.

Doctor H. H. Knight of the University of Minnesota has accepted an assistant professorship in entomology at Iowa State College. He will begin work at Ames in September.

Mr. R. C. Burdette, a graduate of the University of Maryland in 1923, has been appointed to a graduate assistantship in the Department of Entomology of the University of Maryland.

According to *Science*, the Alexander Dyer MacGillivray collection of Tenthredinoidea has been purchased by the University of Illinois. The collection includes more than 400 types and about 1,000 species.

Professor Wallace Park who is in charge of the apiculture work at the University of Illinois is completing his work for a Doctor's degree at Iowa State College this summer.

Miss Pearl Anderson, Instructor in Zoology, University of Maryland, will go on half-time during the session of 1924–25, in order to take advanced work in the Department of Entomology.

Dr. F. C. Craighead, Bureau of Entomology, spent several days during May in

the vicinity of Asheville, N. C., examining southern pine beetle outbreaks and control work conducted during the previous winter.

Mr. William B. Turner, connected with the Bureau of Entomology for about fifteen years, and an associate member of the Association of Economic Entomologists, died at Sacramento, California, June 11, 1924.

Dr. N. E. Winters, head of the division of boll weevil control of the South Carolina Station has accepted an appointment with the division of cotton investigations of the Argentine Ministry of Agriculture.

According to the *Experiment Station Record*, H. A. Ballou is now professor of zoology and entomology at the Imperial College of Tropical Agriculture at St. Augustine, Trinidad, which was formally opened in October, 1922.

Mr. E. E. Russell, Bureau of Entomology, green bug and grasshopper investigations, Gainesville, Texas, has been transferred to Yuma, Ariz., to start an investigation of the alfalfa seed chalcid under direction of V. L. Wildermuth.

Messrs. H. L. Person and Albert Wagner have just completed a survey of the cut-over areas of the Sierra National Forest, to determine the extent to which insect losses are affecting the second crop of timber.

Prof. A. F. Conradi, State Entomologist of South Carolina, and a delegation from his State visited the peach insect laboratory of the Bureau of Entomology at Fort Valley, Ga., on May 20, to observe investigations under way.

Dr. J. D. Tothill returned to Canada from England on April 19. Shortly after his arrival, and accompanied by Mr. Simpson, a three weeks' trip was taken in the Nictau Lake district, investigating borer injury in fire-killed timber.

Entomological work and other work in Rhode Island is being held up or greatly handicapped because of the filibuster in the State Senate through which all appropriation bills and practically all other business is prevented from receiving consideration.

Prof. B. B. Fulton of the Oregon Agricultural Experiment Station and College has resigned to accept the position as Assistant Entomologist and instructor of entomology in the department of zoology and entomology at the Iowa State College. Professor Fulton began work at Ames July 15th.

Mr. E. Hargreaves of the Royal College of Science, South Kensington, London, formerly a Carnegie scholar who traveled and studied in the United States, has just been appointed entomologist in Sierra Leone. He planned to sail on June 11th.

Mr. Rodney Cecil, a graduate student in entomology at Iowa State College has accepted a position as Junior Entomologist with the Bureau of Entomology. He is working under the direction of Mr. Neale Howard in the Mexican Bean Beetle work at Birmingham, Ala.

Professor Ralph H. Smith closed his work in spreader research for the Golden State Milk Products Company (California Central Creameries) on June 1. He is now connected with the Department of Entomology, University of California, at Berkeley, where he should be addressed.

Mr. S. F. Potts, M.S., University of Maryland, 1924, has been appointed to a fellowship at Ohio State University, and during the summer will work on a temporary appointment in the Bureau of Entomology at the new Mexican Bean Beetle Laboratory in Ohio.

According to *Science*, Dr. William M. Wheeler, professor of entomology and dean of the faculty of the Bussey Institution at Harvard University, has been named to represent the University as exchange professor in France during the second half of the next college year.

Mr. Alan P. Dodd, who has been sent from Australia to take up the work on cactus insects recently relinquished by J. C. Hamlin, had a conference with the latter and Dr. W. D. Hunter at Tallulah, La., on May 20. He visited Washington later.

Entomological News announces the death of the following entomologists: Arthur Hugh Jones, English Lepidopterist, February 22, 1924; Herbert Campion, temporary assistant in Entomology, British Museum, January 24, 1924; Thomas A. Annandale, Director of the Zoological Survey of India, died at Calcutta, April 10, 1924.

Mr. Ivan L. Ressler, instructor in zoology and entomology at Iowa State College, has secured a leave of absence in order to complete his work for a Doctor's degree at the University of Pennsylvania. Mr. Ressler has a temporary instructorship in zoology in the University of Pennsylvania.

Recently the Dominion Entomologist arranged with the Director of the Northwest Territories Branch of the Department of the Interior for collections of insects to be made by the Reverend Mr. Hoare in Arctic localities during the next two years. Mr. Hoare left for the north early in June.

Mr. Leonard S. McLaine, Chief of the Division of Foreign Pests Suppression of the Entomological Branch, Canadian Department of Agriculture, was married June 10, in St. Alban's Church, Ottawa, to Miss Kathleen Meredith Lett. Mr. and Mrs. McLaine sailed June 12 for a six weeks' trip in England.

Mr. N. F. Howard, Bureau of Entomology of Birmingham, Ala., recently visited Columbus and other points in Ohio, to prepare plans for the establishment of a new temporary substation at Columbus for the study of the Mexican bean beetle in its occurrence in Ohio. He also conferred with State and University officials.

The following appointments to the staff of the Canadian Entomological Branch have been announced: R. M. White, R. D. Bird, Treesbank; Walter Carter, H. E. Gray, Lethbridge; A. W. Woods, Strathroy; A. J. Graham, Vineland; T. Armstrong, G. A. Hammond, Hemmingford; E. A. Randall, Vernon, B. C.; N. A. Patterson, Annapolis Royal; G. S. Walley, H. H. Thomas, K. F. Auden, Morna Bonell.

A new project of the State Entomologists' office of Wisconsin is assistance to the state institutions in reducing insect losses. The State Board of Control has placed a trained agriculturist in charge of the farms and truck gardens at the seventeen state institutions and the staff of the state entomologist's office is making a survey of the premises at the different locations and arranging for improvements in insect control.

Mr. Louis A. Stearns, Associate Entomologist with the Virginia State Crop Pest Commission and Assistant Professor of Entomology at the Virginia Polytechnic Institute, Blacksburg, resigned his position April 1, to accept the position of Assistant Entomologist at the New Jersey Agricultural Experiment Station, New Brunswick, where he is continuing his investigation of the Oriental Peach Moth.

Messrs. K. L. Cockerham, of Biloxi, Miss., and S. C. Brummitt, of Silverhill, Ala., both of the Bureau of Entomology, recently met with the authorities of the Alabama State Board of Agriculture at Mobile, Ala., to formulate further plans for the future

conduct of the sweet-potato weevil eradication work in Alabama in co-operation with the above board.

Dr. Paul S. Welch was elected Editor of the Michigan Academy of Science, Arts and Letters at the twenty-ninth annual meeting held at Ann Arbor, April 2–4, 1924. Dr. Welch presented a paper on "Observations on the Early Larval Activities of *Nymphula maculatis* (Lepidoptera)" and jointly with L. P. Wehrle, "A New Form of Acarinid Parasitism in Orthoptera."

According to the *Official Record*, a very large shipment of parasites of the Japanese Beetle has just been brought into this country on its way to the laboratory at Riverton, N. J. It weighed about 8,000 pounds, entered through the port of Seattle, and was shipped overland by parcel post to insure prompt movement at the lowest possible rate.

Dr. J. M. Aldrich left on May 31 for a two months' trip through the West. He will visit Kansas City and Atherton, Mo., San Francisco, Berkeley and Redlands, Calif., Portland, Ore., Pullman and Seattle, Wash., and other points, where he expects to do some collecting and consult with various specialists. He will also spend several weeks visiting relatives and friends.

Mr. J. E. Dudley, Bureau of Entomology, of Madison, Wis., has opened a branch laboratory for the summer at Columbus, Wis., where extensive tests will be conducted on the control of the pea aphis with various insecticides and the aphidozer which he designed last year. Any observations of particular interest on the pea aphis should be sent to Mr. Dudley, at Columbus.

Mr. S. A. Rohwer left Washington on May 28 for the purpose of investigating the practicability of introducing parasites into the forestry plantation at Halsey, Nebr., as a check on the ravages of the pine tip moth, *Evetria bushnelli*. This moth is causing severe damage to the pines on the reforestation project there. Mr. Rohwer will be absent for a month, or possibly more.

Mr. J. C. Hamlin, formerly employed by the Federal Horticultural Board, and more recently in charge of the entomological work for the Commonwealth Prickly Pear Board of Australia, was reinstated in the Bureau of Entomology on May 2, and assigned to duty at the Boll Weevil Laboratory at Tallulah, La. Mr. Hamlin is to give attention to the chemotropic responses of the boll weevil.

On May 14 and 15, Messrs. Plank, Whitcomb and Catchings of the Bureau of Entomology, with Ed. Foster, Collaborator of the Federal Horticultural Board, judged an exhibit of insects at New Orleans, in which two New Orleans Normal School classes and seven New Orleans grade schools competed for local prizes. These exhibits are held twice a year and a great deal of interest is shown in them by all the students.

Mr. Eric Watson, of Westacres, Pont Tail Road, England, appointed to the staff of the Entomological Branch, Canadian Department of Agriculture, as an Assistant Entomologist, reported for duty on April 14. Mr. Watson was born in Edinburgh, Scotland, and is a graduate of the Imperial College, London, England. He is making a systematic study of sawflies and will be glad to identify any material the field officers may care to send in.

Professor Harold R. Hagan, Salt Lake City, Utah, was elected First Vice President of the Utah Academy of Sciences at the seventeenth annual meeting held April 4–5,

1924, at the University of Utah, Salt Lake City. Professor Hagan was joint author of two papers presented at the meeting: "Embryonic Development of the Chinese Mantid," Harold R. Hagan and L. W. Sorenson: "Embryonic Development of the Telson of the Chinese Mantid," Harold R. Hagan and Miss Eva Hansen.

According to *Science*, the Northwest Association of Horticulturists, Entomologists and Plant Pathologists will hold its seventh annual meeting at Penticton, British Columbia, August 26–29, 1924. The membership of this association includes those interested in the three sciences in the States of Oregon, Washington, Idaho, Utah and Montana and in the province of British Columbia. The Pacific division of the American Phytopathological Society will also hold its annual meeting at the same time and place.

Recent appointments in the Bureau of Entomology have been announced as follows: B. S. Brown, Jr., field assistant at Fort Valley, Ga., curculio investigations; Basil E. Montgomery, Vincennes, Ind.; Rodney Cecil, Iowa State University, Mexican bean beetle investigations, Birmingham, Ala.; T. E. Bronson, field assistant, pea aphis investigations; Carleton Burnside, apicultural investigations; L. F. Greer, boll weevil laboratory; A. H. MacAndrews, forest insect investigations, Asheville, N. C.; E. J. Udine, grasshopper investigations, Billings, Mont.; John W. Nuttycombe, jointworm investigations, Charlottesville, Va.

At the thirty-fourth annual meeting of the Ohio Academy of Science, held at the Ohio State University, Columbus, April 18–19, 1924, papers were read by entomologists as follows: The Relation of Fish Production to Forestation, Raymond C. Osburn; Respiration in the Orthoptera, M. O. Lee; The Periodical Cicada in Ohio, H. A. Gossard; An Ohio Record for the Dragonfly (*Tachopteryx thoreyi*), James S. Hine; Ecologic Notes on Some Homoptera of the Southwest, Herbert Osborn; Some Practical and Theoretical Aspects of Lubricating Oil Emulsions as a Scalecide, L. L. Huber.

A meeting of entomologists, agronomists, railroad agricultural agents, and others interested in insect control in the southwestern winter wheat area, was held at Kansas City, Mo., May 24. A uniform plan for chinch bug control in the states of Iowa, Nebraska, Kansas, Missouri and Oklahoma was adopted and a committee was appointed to draft a similar program for Hessian fly control. Entomologists in attendance were: M. H. Swenk, H. B. Hungerford, J. R. Horton, C. J. Drake, I. L. Ressler, E. G. Kelly, J. W. McColloch, Otis Wade, L. Haseman, K. C. Sullivan, C. E. Sanborn, A. F. Satterthwait, Wm. Moore and V. I. Safro.

During the first part of May a preliminary examination of the proposed forest insect control project in the Missoula National Forest was made by J. C. Evenden and Elers Koch, Assistant District Forester, District 1. This project calls for a line of defense against the heavy epidemic of the mountain pine beetle, which threatens the valuable lodge-pole pine stands of the Deerlodge and southern Missoula National Forests. At the present time H. J. Rust, Entomological Ranger of this station, is marking the trees that are to be treated, and it is expected that control work will be started by May 22.

Dr. S. A. Graham, of the Lake States Forest Experiment Station, and Dr. S. B. Fracker, state entomologist of Wisconsin, made a survey through the jack pine growing areas of Wisconsin in June looking up insect infestations. It was found that the jack pine sawfly, which is locally injurious in certain other pine areas of the

Lake States, does not seem to be causing any damage in Wisconsin this season. It was also discovered that the pine tussock moth (*Olene leucophoea*) of which there was a serious outbreak in Burnett and Bayfield counties in 1922, seems to have been completely cleaned up for the present, at least, by natural enemies and disease.

Mr. Arthur Gibson, Dominion Entomologist of Canada, attended the annual meeting of the Quebec Society for the Protection of Plants, which was held at Macdonald College, during the third week of April. During the evening session he gave a brief account of a recent hearing which he attended in Washington, D. C., regarding the movement of Christmas Trees from the Quebec Province into the United States and showed maps indicating the area in Quebec Province upon which the Federal Horticultural Board has placed an embargo. He also spoke of the recent infestation of the gipsy moth found at Alburg, Vermont. During the following day he went to Montreal and spent a short time with the inspection officers at that port.

Mr. C. H. Curran, who has been connected with the Division of Systematic Entomology, Entomological Branch, Canadian Department of Agriculture, as Assistant Entomologist, for the past year and a half, relinquished his position on April first on promotion to the position of Entomologist in Charge of Stored Products Insect Investigations, formerly held by Mr. E. H. Strickland. Mr. Curran will continue in charge of the Diptera in the Canadian National Collection, in addition to the work entailed in his new duties. He proposes to complete as far as possible the collection of insects attacking stored products and will also take up the study of mites, especially those groups whose members are of economic importance. Mr. Curran spent his holidays during the latter part of March and early April at Cornell University, studying the Diptera in the collection. Arrangements were made for the exchange of specimens with the Canadian National Collection.

At the invitation of Samuel Henshaw and Nathan Banks of the Cambridge Museum of Comparative Zoology, and Professors W. M. Wheeler and C. T. Brues, of Bussey Institute, Dr. E. A. Schwarz, accompanied by R. C. Shannon, went for several days to Cambridge and Boston. At the Cambridge Museum, Dr. Schwarz made an examination of the Coleoptera collections of Le Conte, Melsheimer, Ziegler, and others, and helped Mr. Banks elucidate a number of tangles existing among the various labels on the specimens, and clear up other points relating to type specimens. Mr. Shannon studied the types in the Osten Sacken-Loew collection. The Entomological Society of Cambridge had a special meeting, a smoker, in honor of Dr. Schwarz. Here he met a number of his old friends and many new entomologists who are now members of this club. C. W. Collins took Dr. Schwarz for a visit to the Gipsy Moth Laboratory at Melrose Highlands, where he met the personnel and was shown the different phases of their work.

Horticultural Inspection Notes

Mr. P. A. Glick has been transferred from New York to Washington, where he will be located permanently.

Mr. Charles E. Prince, Jr., has received a temporary appointment in the Plant Quarantine Inspection Service and is stationed at New York City.

Mr. Napoleon Beaudoin, B.S.A., was recently appointed to the position of Insect Pest Investigator for the Montreal Inspection Staff, and reported for duty May 16.

Mr. L. R. Gagnon, B.S.A., graduate of Ste. Anne de la Pocatiere Agricultural

College, has been appointed as District Inspector on the Montreal Staff and reported for duty March 25.

A Fruit Fly taken from a fruit of the Mango, originating in Costa Rica and intercepted at Boston, Mass., has been identified by Dr. Aldrich as *Anastrepha distans* Hender., a rare species.

Fly larvae taken from the fruit of Sapodilla from Dominica, British West Indies, and intercepted at New York city on May 7, 1924, were identified by Mr. C. T. Greene as *Anastrepha serpentina* Wied.

A disease commonly known as Citrus Canker was found on oranges intercepted in the baggage of a passenger arriving at Seattle from Japan. The interception was made by Mr. E. I. Smith on June 16, 1924.

Mr. W. A. Fowler has recently been appointed to the position of District Inspector in the Toronto district and in addition to being responsible for the inspection of imported and exported nursery stock in that territory, will also maintain the enforcement of the corn borer quarantine.

Mr. W. St. G. Ryan, who has been on the staff of the Canadian Entomological Branch for two years and transferred from Toronto to Montreal last fall as acting officer in charge, was appointed to the permanent position of Junior Entomologist in charge of the Port from April 1st.

Dr. C. L. Marlatt left Washington on June the 20th to attend the Pan-Pacific Food Conservation Conference, in session at Honolulu from July 31st to August 14th inclusive. While in the Hawaiian Islands, Dr. Marlatt will investigate the Fruit Fly situation in the Islands and confer with the Inspection force on matters relating to Plant Quarantine Inspection.

An examination of seed cotton used as packing for cotton-gin saw bands being shipped by mail from Mexico to Alabama, was made at Nogales, Arizona. Weevils taken from the shipment were identified by Dr. E. A. Schwarz as *Anthonomus grandis* Boh., apparently of the typical form.

The inspectors of the Federal Horticultural Board, while examining a shipment of grapes at New York City arriving from the Argentine Republic, intercepted a Coccinellid which was identified by Dr. Schwarz as *Epilachna paenulata* Germ. Dr. Schwarz commented as follows: "This is one of the phytophagous species of Coccinellidae the introduction of which into the United States is by no means desirable."

Mr. R. W. Sheppard, who has had considerable training in biology, in England, and who was employed last season on Corn Borer work, has been appointed permanent District Inspector at the Canadian Port of Niagara Falls. Mr. Sheppard was stationed at this port in a temporary capacity during the fall and winter months.

Mr. Ralph A. Sheals, Assistant Entomologist in Rhode Island, spent a period of approximately six weeks in March, April and May in St. Louis and Kansas City inspecting nursery stock in transit from the Eastern United States to the Rocky Mountain and Pacific Coast States. This work is being carried on in connection with the effort to check the spread of white pine blister rust.

The headquarters staff of the Canadian Entomological Branch was rushed continually through the winter and spring in connection with the issuance of permits for nursery stock importations and related work. The entry of many prohibited plants was checked by means of the permit system and it is felt that a very satisfactory check

is obtained on all nursery stock entering Canada and especially from Europe. A total of 4,653 permits had been issued for United States shipments on May 12, and 2,563 permits for importations from other countries. The value of the nursery stock examined by the inspectors between March 24 and May 12 was approximately $135,000.00.

Dr. Hunter has reported that in the inspection of automobiles in inter-state traffic from New Mexico to Arizona during a period of about seventeen months,from November 24, 1922, to April 29, 1924, a total of 31,006 cars were inspected. The inspections resulted in the interception of 2,975 cotton sacks, 94 lots of cotton carried as souvenirs, 327 mattresses and pillows stuffed with cotton, 2,221 Citrus fruits, 327 lots of cotton seed and seed cotton, and 578 lots of other contraband material. Numerous specimens of larvae and adults of the Boll Weevil were found in confiscated materials and on May 16, 1924, two living specimens of the Pink Boll worm were found in a sack of cotton being carried to California.

Dr. S. B. Fracker has reported as follows in regard to the inspection of automobiles carrying trees and shrubs within the State: "Under a co-operative arrangement with the state Conservation commission, the conservation and game wardens of Wisconsin are deputized by the State Department of Agriculture to assist the state entomologist in preventing general violations of the nursery inspection law. Like that of most states, the Wisconsin statute prohibits the transporting of uninspected trees and shrubs for propagation. The transporting of material of this kind for long distances bid not often occur until about 1922 when tourist traffic increased enormously. During the summer of 1923 the wardens and nursery inspectors intercepted 657 autos carrying trees and shrubs. Detailed reports were made on 57 of these cases. It was found that 39 of these were destined for points within the state and 18 for outside points. Fourteen of the 57 autos were carrying White Pine, coming either from the blister rust infected areas of the state or sections adjacent thereto. The wardens are given no authority to make inspections but when contraband material is found they are usually able to arange either for the destruction of the plant material or its shipment to the state entomologist's office for inspection. Posters advising tourists of the regulations are put up in the various public camp grounds."

Apicultural Notes

The sixth annual summer meeting of the Michigan Beekeepers' Association was scheduled to be held at Travers City, Mich., August 6–7.

The annual summer field meeting of the Ohio Beekeepers' Association at the Hartman Farm, near Chillicothe, on August 1, has been announced.

The summer field meeting of the Connecticut Beekeepers Association was held on Saturday, July 5, at the summer home of Mrs. Charles Pettee at Higganum.

Dr. E. F. Phillips will attend the annual summer meeting of the New York State Federation of Beekeepers' Societies to be held in Canajoharie August 1.

Mr. John G. Jessup, instructor in apiculture, Iowa State College, has resigned to accept a position with the A. I. Root Company, Medina, Ohio. He will be located at the branch office, Council Bluffs, Iowa.

The Mid-West Horticultural Exposition to be held at Waterloo, Iowa, next fall, will have a large premium list for the bee and honey exhibits. Application for space

should be made to the superintendent of the Apiary Department, Professor F. B. Paddock, Ames, Iowa.

Dr. E. F. Phillips and Jas. I. Hambleton attended the meeting of the Maryland Beekeepers' Association at College Park, Maryland, on May 31, and will attend the annual summer meeting of Wisconsin beekeepers held by the University of Wisconsin, to be held at Fond du Lac, August 12–14 inclusive.

The Maryland Beekeepers' Association paid its annual visit to the Bee Culture Laboratory of the Bureau of Entomology on the afternoon of July 12, at which time the various members of the staff discussed their respective lines of work. About 60 members of the association were in attendance.

Dr. A. P. Sturtevant of the Bureau of Entomology went to Wyoming and southern Montana in June to study an outbreak of sacbrood. This disease appears to occur more abundantly in this region than in most other parts of the country. Dr. Sturtevant was accompanied on most of the trip by Prof. C. L. Corkins of the University of Wyoming.

All co-operative extension work in apiculture has been discontinued by the Bureau of Entomology. R. B. Willson will continue his work in New York under the administration of Cornell University, and Mr. C. L. Sams who has been doing similar co-operative work in North Carolina, will also be continued without support from the Bureau. The co-operative work in Wisconsin was discontinued July 1.

Dr. E. F. Phillips, who has been in charge of the beekeeping work of the Bureau of Entomology for the past nineteen years, will resign from the Bureau October 1 to become Professor of Apiculture in the Department of Entomology, Cornell University. *Gleanings in Bee Culture* for July gives a summary of the work done in the laboratory under the direction of Dr. Phillips. It is expected that announcement of the appointment of a new Apiculturist will be made in the near future.

The final program of the VII International Apicultural Congress to be held in Quebec September 1–4 has recently appeared. The sessions of the days indicated will be devoted to the discussion of papers on beekeeping subjects. Following this part of the Congress a series of excursions has been planned to continue until September 10, including a week-end excursion to the Saguenay River by boat from Quebec and closing at Montreal. Details of the program may be obtained from M. Cyrille Vaillancourt, local secretary, Ministéré d'Agriculture, Quebec. All papers will be presented in both French and English at separate sessions.

Notes on Medical Entomology

The March issue of the American Journal of Tropical Medicine (Vol. IV, No. 2) contains an article by Geo. H. Bradley of the Mound, La., laboratory of the Bureau of Entomology, entitled "The Natural Breeding Places of Anopheles Mosquitoes in the Vicinity of Mound, Louisiana."

On May 5, Mr. R. C. Shannon, at the request of James Ricker and with the permission of the Bureau of Entomology, went to Poland Springs, Me., where he spent ten days investigating the mosquito situation of the Poland Springs estate. The North Woods Aëdes species were found to be very abundant in the temporary pools and small ponds about the place. Control measures were immediately started. Investigations of other insects were made at the same time. On his way back, Mr. Shannon stopped off to see the collections of Diptera at Cambridge and Boston.